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THE EVOLUTION AND DEVELOPMENT OF SURGICAL INSTRUMENTS

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III. THE SAW

THERE is evidence from specimens which have been excavated in various parts of the world that the saw has been known to man from the neolithic period. The idea of the toothed implement for cutting bone or wood may have been suggested to him from such natural objects as the sawfish with its sharp projections or the finely serrated tooth of the shark, which is believed to have been used for cutting bone from prehistoric times.

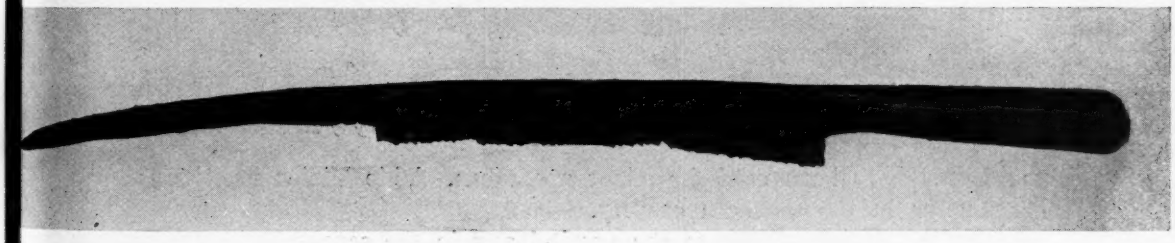

FIG. 330.—Flint saw-blades set in a wooden haft. Egyptian: pre-dynastic (before 3300 B.C.).
(*By courtesy of the British Museum.*)

Pliny ascribes the origin of the saw to Daedalus or his nephew Perdix, who was supposed to have conceived the idea from the jaw of a serpent with which he found he was able to cut a piece of wood. But whether there is any truth in this mythological story or not, saws with blades of finely flaked flint with serrated edges have been discovered in the lake dwellings in Switzerland and also in Egypt, dating from at least 2700 B.C. A specimen mounted in wood with a handle, now in the British Museum (*Fig.* 330), is said to be of the pre-dynastic period, and shows the tool as used by the Egyptians over 4000 years ago. The flint blade was superseded by metal in later times, and the saw represented in a painting at Thebes about 1500 B.C., shows the Egyptian carpenter using a tool similar in shape to that employed to-day (*Fig.* 331).

In ancient Greece, saw-blades of copper were first used, but they were succeeded by bronze, which was found to be harder and more durable. It is not, however, until we come to the Roman period, a century or two before the Christian era, that we find blades of iron and steel. The saws used by the Romans were chiefly of the tenon type (*Fig.* 332), but that they also employed the bow or frame pattern is evidenced from a carving on stone, now in the museum of the Capitol at Rome, representing instruments used in sacrificial rites (*Fig.* 333).

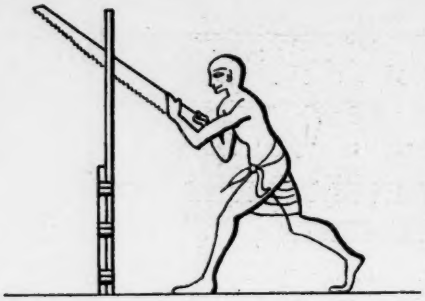

FIG. 331.—Sawing wood in Ancient Egypt. (*From a wall-painting at Thebes, c.* 1500 B.C.)

Allusions to the use of the saw for surgical purposes are made by several of the classical writers, and among others by Celsus (25 B.C.–A.D. 50) in his description of the amputation of a gangrenous limb, in which he says, "it must be divided with the saw close up to the sound flesh; the end of the bone is next to be smoothed where the saw has left any asperity."*

Mention is made of a knife-shaped or sword saw by Galen, which he describes as having a narrow blade continuous with the handle, like a knife, but such saws

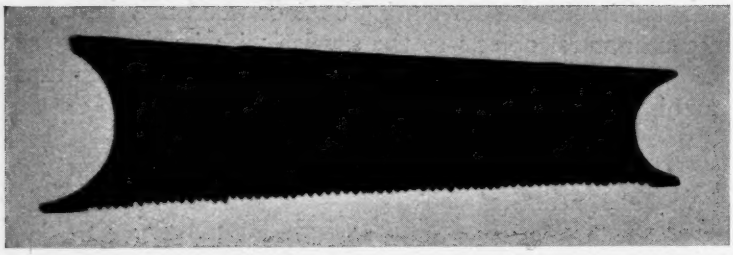

FIG. 332.—Fine-toothed, bronze surgical saw. Roman. *By courtesy of the British Museum.*)

could only have been used for minor operations. Vido Vidius mentions similar instruments in the sixteenth century.

Paul of Ægina alludes to the surgical saw in the seventh century, and the small saws used in cranial operations probably date from about this period.

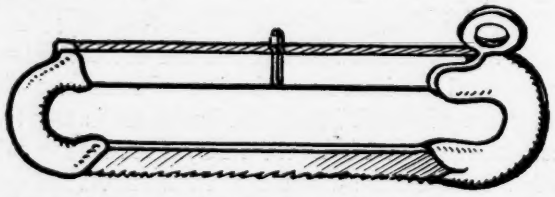

FIG. 333.—Roman bow-saw. (*From a stone relief in the Musée da Capitole, Rome.*)

Our knowledge of the development of the saw is aided by Albucasis and the drawings illustrating the codices of his works of the twelfth and thirteenth centuries in the Bodleian Library and the British Museum. Several types are depicted

* CELSUS, Book VII, Cap. 33.

which show that the bow as well as the tenon saw was employed by the Arab surgeons (*Fig.* 334). One represented in the manuscript in the British Museum is interesting, as it shows the cutting blade strengthened and stiffened by plates connected with the rigid back.

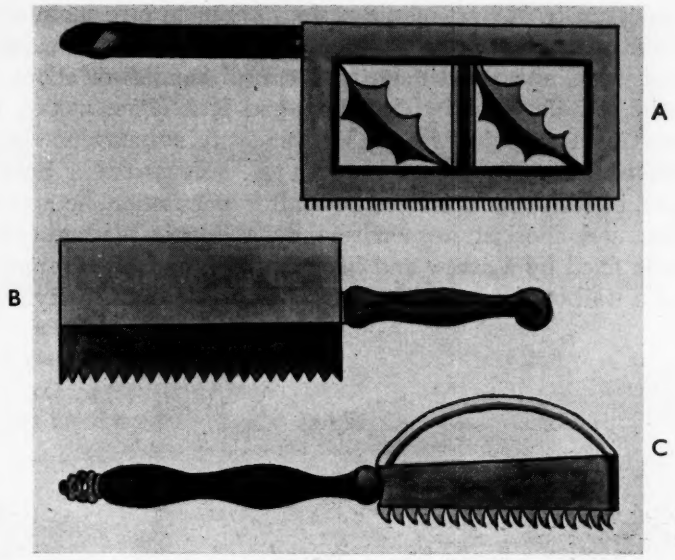

FIG. 334.—Surgical saws: A, Twelfth century, *Albucasis Chirurgia* (B.M. Add. MSS. 36617); B and C, Thirteenth century, Albucasis Arab MS., Marsh 54, Oxford.

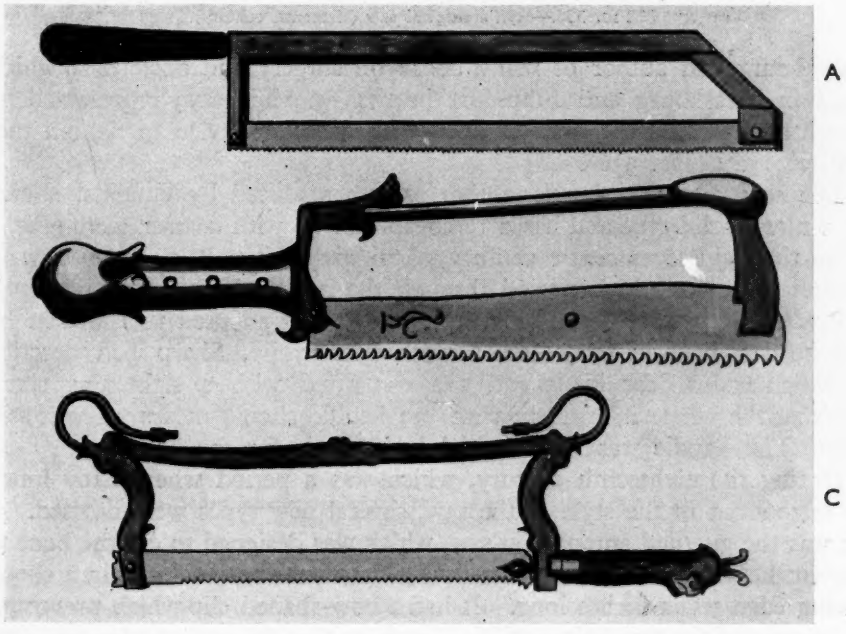

FIG. 335.—Surgical saws: A, John Wryghtson, 1350; B, Vesalius (sixteenth century); C, Gersdorff (sixteenth century).

A small cranial saw with a crescent-shaped blade fixed to a long straight handle is also depicted, similar to the drawing illustrating Wryghtson's manuscript in St. John's Library at Oxford. Wryghtson's larger saw (*Fig.* 335 A) has an angular prow and is of the bow pattern similar to that used by Vesalius in the sixteenth century (*Fig.* 335 B). In the sixteenth century, the Italian and French craftsmen, influenced by the art of the period, began to give more attention to the mounting of the saws used by surgeons. They enriched the backs with scrolls and ornamental work, and fitted them with carved handles of ebony or rosewood, as shown in the saw depicted by Gersdorff and Ryff (*Figs.* 335 C, 336).

Hans von Gersdorff, who was a German army surgeon and an experienced and successful operator, flourished about 1500. He wrote a book on military surgery in 1517, in which he describes how, after amputation, he applied a bandage without sutures and checked hæmorrhage by a caustic plaster. His saw had a removable blade fixed by a screw and hooks at each end of the frame to enable it to be hung on a wall or the pole of a tent. Walther Hermann Ryff was a surgeon

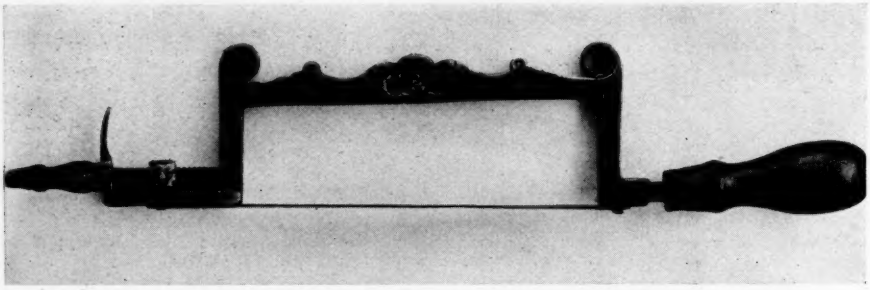

FIG. 336.—Ryff's surgical saw (sixteenth century).

of Strasbourg and author of many books on surgery and obstetrics, which were printed in Strasbourg and Frankfurt in 1541–5. His saw, represented with an ornamented frame, is the first depicted with a screw device to tighten the blade when necessary (*Fig.* 336).

The saw represented among the instruments used by Vesalius, about 1550, is of a more, solid type and has a removable blade with coarser teeth (*Fig.* 335 B).

In the mid-seventeenth century, Scultetus depicted a heavy saw with a thumbscrew device which passed through the handle in order to tighten up the blade when it became loose (*Fig.* 337 A). Perrett adopted this idea in his saw, which he described in 1779 (*Fig.* 337 B). Meanwhile, Sharp had described his saw, which had a deep blade and was also fitted with a tightening screw, and stated that the whole instrument with the handle should measure about seventeen inches. The handle was shaped, and had a hole for the finger.

During the eighteenth century, which was a period when many innovations were introduced in the style of the saw, several new types were devised. Among them was the guarded amputation saw, which was designed to cut the bone without injury to the soft parts. It consisted of a flat metal bar enclosed in a sheath with a sawing edge seven inches long. It had a bow-shaped clip which prevented complete closure of the two halves of the sheath, so that the sawing edge was constantly exposed. The inventor of this ingenious instrument, a specimen of which is to

be seen in the Museum at the Royal College of Surgeons, is unknown (*Fig.* 338 A). Later on, Charles Griffiths, of Edinburgh, introduced a circular amputation saw which was operated by a coiled spring. The instrument consists of a circular

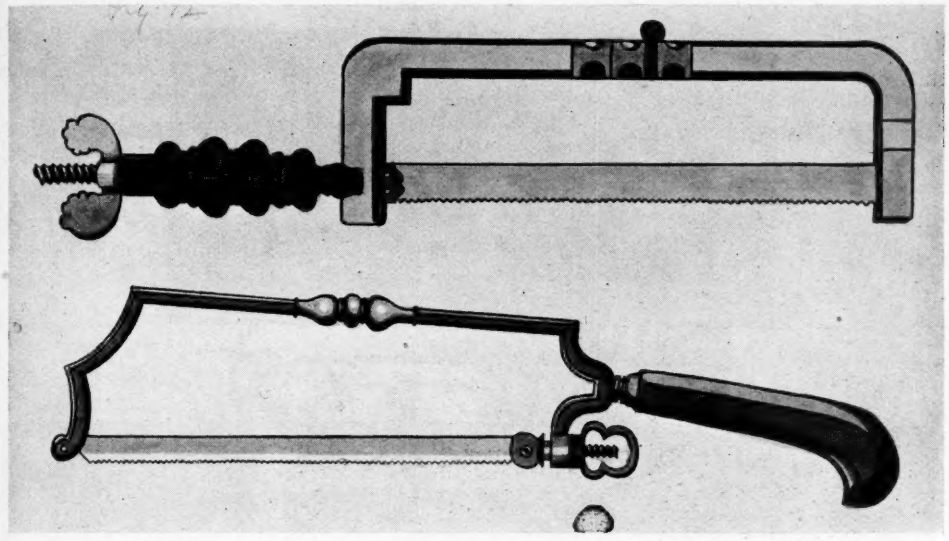

FIG. 337.—Surgical saws: A, Scultetus (seventeenth century); B, Perret (eighteenth century).

saw with large teeth working with geared cogs on the spring. A key winding the spring brings a toothed-wheel on to a spring pawl which is fixed to the larger cog-wheel that drives a smaller cog-wheel attached to the spindle of the saw. It has

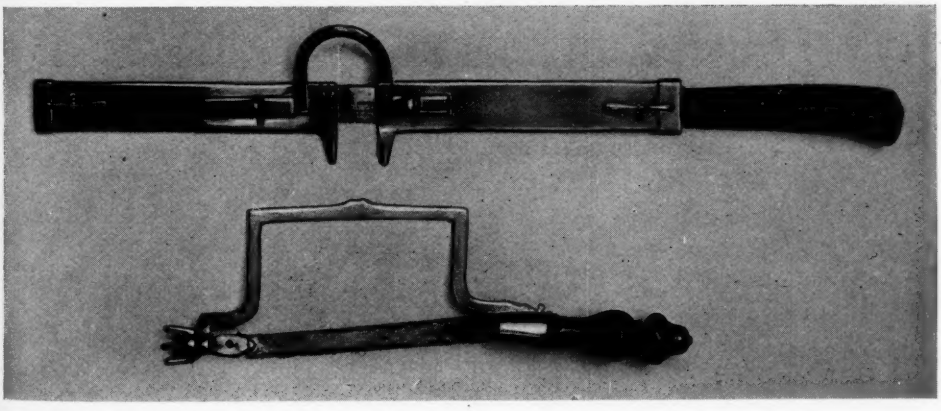

FIG. 338.—A, Guarded amputation saw for cutting the bone without injuring the soft parts (eighteenth century); B, La Faye's bow-saw (*c.* 1740).

a strong handle of turned rose-wood with a steel finger-guard, but the whole instrument is very heavy and was certainly one which would have required great skill to manipulate. This brought other types of circular saws, the mechanism of which was even more complicated, so it is little wonder they never came into general use.

In 1740, La Faye introduced a small saw of the bow type with a removable blade which could be tightened by a screw at the end of the frame (*Fig.* 338 B), which may be regarded as a forerunner of the metacarpal saw designed by Benjamin Bell (*Fig.* 339).

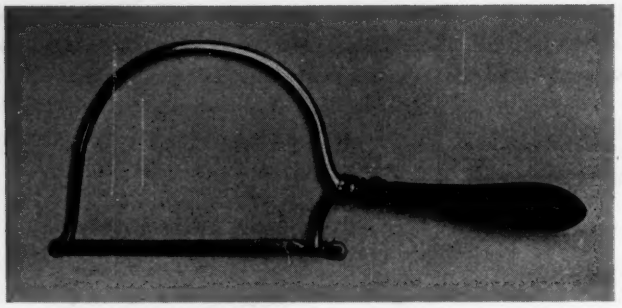

FIG 339.—Benjamin Bell's bow metacarpal saw (1750).

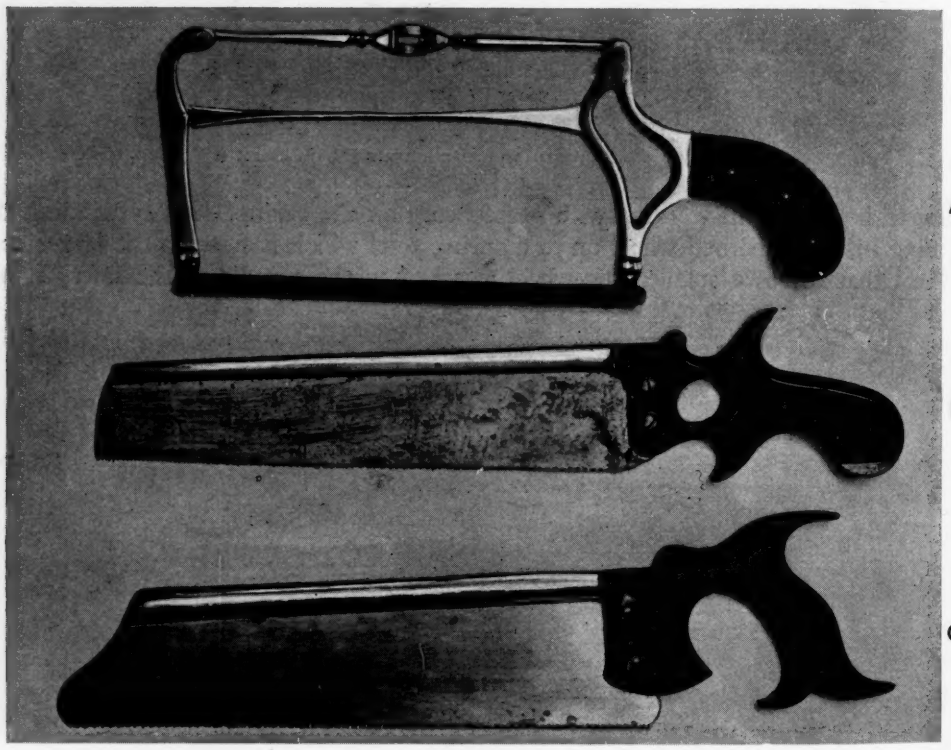

FIG. 340.—A, Butcher's saw; B, Tenon saw used by an army surgeon on the field of Waterloo (nineteenth century); C, Tenon saw used by Fergusson and Lister (nineteenth century).

About the middle of the eighteenth century a change was made in the form of the saw. The bow or frame shape gave place to the tenon blade, and so in the nineteenth century the name amputation saw became identified with an instrument having a straight back and deep solid blade, like the carpenter's tool.

Assalini commented on its advantages and it became the favourite-shaped saw of Percival Pott, and later was preferred by Fergusson and Lister. Savigny figured an example of this type in 1798, and remarks: "it is the saw now in universal use and is distinguished by the neatness of its construction and facilitation of its management from that formerly made with a frame or bow, and by its appelation 'Potts' from the preference constantly bestowed upon it by that very celebrated operator".

But this did not entirely extinguish the bow saw, for in 1851 Richard G. H. Butcher introduced a modification for which he claimed many advantages. In

FIG. 341.—An amputation in progress. (*From a woodcut*, 1528.)

the account of the saw which still bears his name, after describing an amputation below the knee, Butcher states: "the saw which I have used in this operation and which I must strongly recommend now for the first time, is a modification of the bow saw used by cabinet-makers for cutting out fine work when curves are to be executed. The upright pieces are six inches high, half-an-inch wide and two lines thick; the one remote from the handle is received into the transverse bar and is movable. The depth of the blade is three lines ($\frac{1}{4}$ inch), with the teeth well set off from each other and inclined forwards. The length of the blade is six inches, with the sockets included eight and a half inches. The middle bar is

half-an-inch deep and two lines thick, while the upper bar is rounded with a screw at one end".

Butcher claimed that his saw possessed two good qualities—viz., that it readily cut in a curve, and from its slender proportions it could be easily slipped under the flaps and used without bruising them or catching in the retractor (*Fig.* 340 A).

Sir William Fergusson's ideal amputation saw was one with a blade about nine inches long and two and a half inches deep. He favoured a handle of ebony similar in shape to that used by the cabinet-maker, and of such a size that whilst held in the palm it could be firmly grasped by three fingers, the forefinger and thumb being placed parallel with its upper margin to aid in keeping it steady. "The blade," he says, "should be sufficiently firm not to bend on the application of moderate force. The teeth well set out as to make such a breadth of groove as will allow the blade to move in it with facility." (*Fig.* 340 C).

An amputation saw of the army type, and which was actually used on the field of Waterloo, is depicted in *Fig.* 340 B.

In 1870, Weiss introduced a saw with a slotted blade, which was said to prevent the teeth from becoming clogged, but it never came into favour, and subsequent years saw little change. During the present century, several types of minor saws have been devised, such as those suggested by Adams and Annabel, while Heath advocated a saw with a very deep blade; but no radical change has been made in the saw used in amputations, and it still remains very similar in shape to the tool employed in ancient times.

Fig. 341, taken from a woodcut, 1528, shows an amputation in progress in that period. The saw depicted is similar in shape to that used by Wryghtson (*see Fig.* 335 A).

VASCULAR ENDOTHELIOMA OF THE LUNG

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TUMOURS of the lung, other than those of a carcinomatous nature, are comparatively rare, and as those of endothelial origin appear to be exceptional a small group of four such cases is here described. A search of the literature has not revealed any comparable cases. Endothelioma may invade the lung by direct extension from the pleura or by metastasis from a primary meningeal focus, but its origin within the lung appears to be most uncommon, and from a pathological point of view, in these cases, to be of vascular origin.

Jackson[1] has recorded the removal of an endothelial tumour by peroral bronchoscopy from the right second main bronchus of a man of 35 with a history of intermittent bronchial obstruction for five years. The tumour was discrete, nodular, and shiny, and the brief pathological report termed it an endothelioma, but there was some evidence of epithelial origin.

Most other recorded cases suggest an origin outside the lung. Thus Braden[2] has reported a man aged 60 seen shortly before death and diagnosed as pulmonary neoplasm associated with pulmonary tuberculosis. At autopsy an extensive malignant growth involving the chest wall was found, a portion of which on microscopical examination proved to be an endothelioma. Braden himself suggested a possible origin in the pleura, and the characteristic late stage of pleural endothelioma is similar to that described.

Ruberstone and Shmookler[3] record a case of "endothelioma of the lung involving vertebræ and spinal cord". The clinical account of this patient is strongly suggestive of a primary spinal origin and secondary extension into the lung. Banyai and Grill's paper[4] on "so-called pleuro-pulmonary endothelioma" is devoted entirely to a discussion on pleural endotheliomata, with the exception of the statement in an early paragraph that "primary endothelioma of the lung is very rare and most authors believe it originates in the pleura". Adler[5] in 1912 definitely discounted in his opinion the occurrence of endothelioma of the lung, and neither the latest standard medical works nor pathological discussions of endotheliomatous tumours include their incidence in the lung.

Ewing,[6] in a detailed description of endotheliomata, does not mention the lung as a site of origin for these tumours. Besides the meninges, nerve trunks and ganglia, serous membranes, and bones, he describes a form originating from lymph-nodes, and some of these may be perivascular in type. In a description of their structure he refers to their resemblance in the early stages to granulomas, and states that later they may take on carcinomatous or sarcomatous appearances. This is

noticeable in our cases, but clinical study as well as histological considerations lead us to think that these definitely are of endothelial origin.

CASE REPORTS

Case 1.—O. H., female, aged 48, was admitted to the Brompton Hospital on Nov. 26, 1928, under the care of Dr. Burrell. She complained of tightness across the chest and right axilla of a few months' duration, also a respiratory wheeze which had been present for eighteen months. There had been occasional dry cough for the previous twelve months. She had lost no weight and her general condition appeared fairly good. Physical signs showed reduction of percussion note at the base of the right lung and weak breath-sounds. The blood-pressure was 143/90, and other systems appeared healthy.

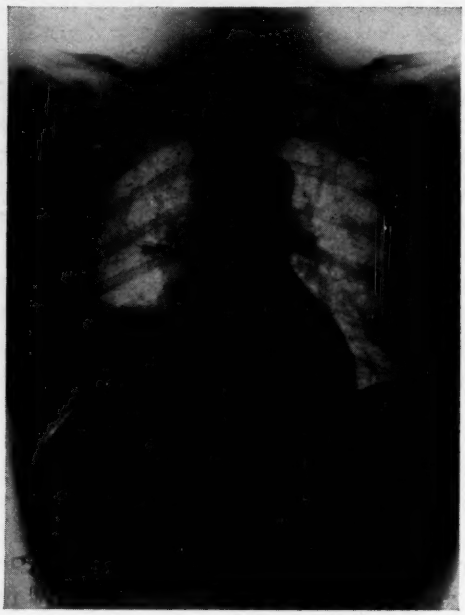

FIG. 342.—*Case* 1. Radiograph of the chest.

X-RAY EXAMINATION.—Radiography of the chest showed the heart to be normal in position but movement of the right side of the diaphragm to be restricted. At the base of the right lung was seen a large well-defined circular opacity close to the mediastinum and extending two-thirds of the way to the chest wall, and another small shadow above this (*Fig.* 342). Following the induction of an artificial pneumothorax, further radiographs demonstrated the tumour to be intrapulmonary.

OPERATION (Dec. 5, 1928).—This was carried out under intratracheal anæsthesia given by Dr. Magill. A thoracotomy was performed, and the right lower lobe was found to be almost filled with a large tumour. Lobectomy was performed by ligation of the lobar vessels and suture of the lower lobe bronchus, and the chest closed, except for an airtight intercostal drain. Healing occurred by first intention and recovery was uninterrupted.

AFTER-HISTORY.—The after-history has been uneventful and the patient reported in January, 1937, eight and a half years after operation, in perfect health.

PATHOLOGY.—The appearance of the cut section of the lobe removed is shown in *Fig.* 343. A defined, encapsulated tumour occupies most of the right lower lobes, leaving only a fringe of normal lung tissue. It has extruded into the bronchus, which, after section, has retracted, allowing part of the growth to project. Microscopical section showed a tumour with appearances suggestive of an endothelial origin.

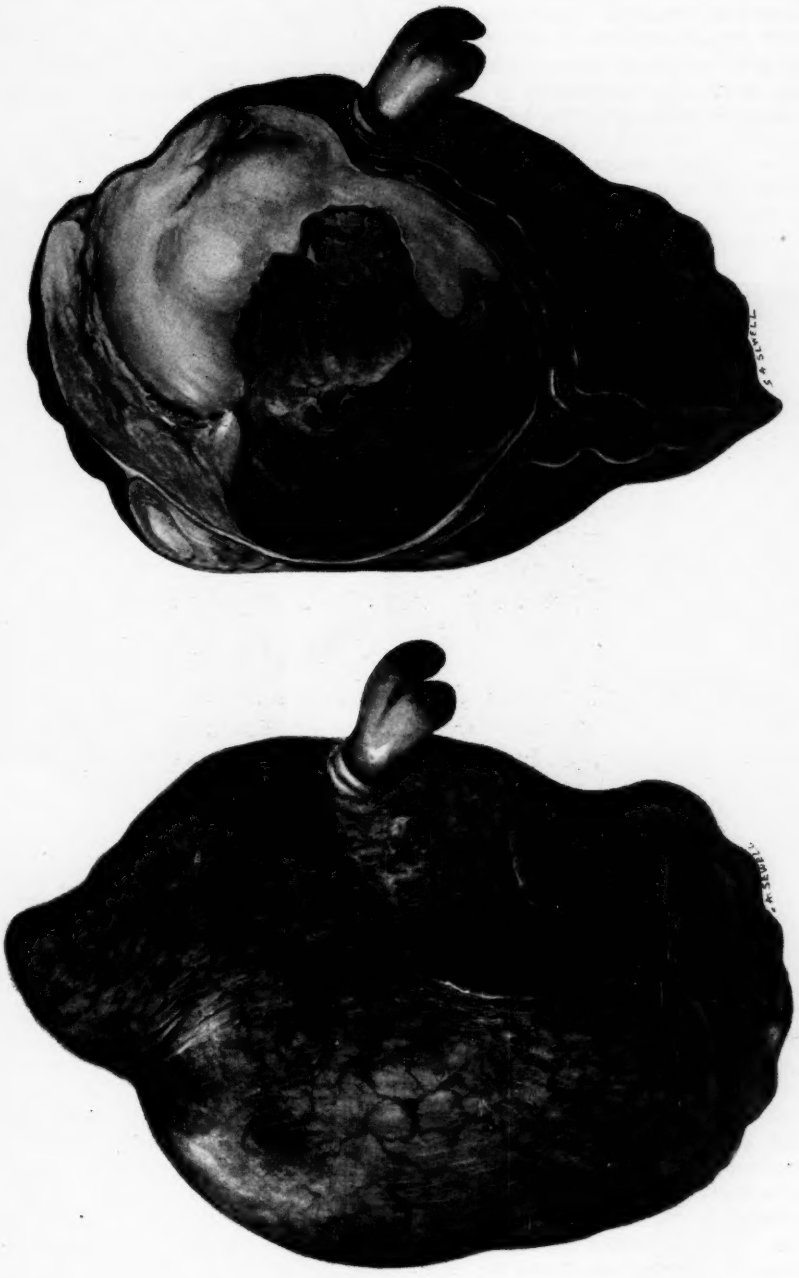

FIG. 343.—*Case* 1. Showing the removed lobe and a section through the tumour.

Case 2.—L. F., male, aged 26, was admitted to the Brompton Hospital on April 6, 1934, under the care of Dr. Fenton, with a history of hæmoptysis of about three ounces two weeks previously. He was in good general condition, with no loss of weight, but complained of slight pain under the left shoulder. Examination of the chest elicited no abnormal signs and the sputum was repeatedly negative for tubercle bacilli.

X-RAY EXAMINATION.—A well-defined rounded opacity was observed in the left middle zone, lying in the plane of, and close to, the hilum of the lung. The lipiodol bronchogram (*Fig.* 344) showed an abnormality in the shape of one of the left secondary bronchi, but there was no definite blocking of the lumen.

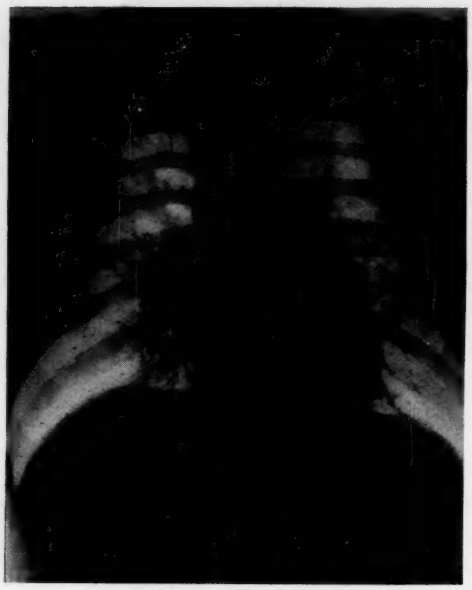

FIG. 344.—*Case* 2. Bronchogram taken before operation.

FIG. 345.—*Case* 2. Showing a cut section through the removed lobe and tumour.

The case was referred to one of us (A. T. E.) and a diagnosis of intrapulmonary neoplasm was made, with a recommendation of exploration after bronchoscopy. This latter procedure was carried out on April 25 under local anæsthesia, and no abnormality was seen in the bronchi of either side.

OPERATION.—This was performed on May 2, after preliminary artificial pneumothorax, under gas and oxygen anæsthesia given by Dr. Machray. The chest was opened in the sixth left intercostal space and a firm mass found in the proximal part of the lower lobe. The lower lobe was removed with its contained tumour.

SUBSEQUENT PROGRESS.—The patient made an uninterrupted recovery and has remained well since, with no further hæmoptyses. Radiography also shows no evidence of recurrence, and a lipiodol bronchogram shows the clean-cut stump of the left lower bronchus and a normal bronchial tree of the upper lobe.

PATHOLOGY.—The cut section of the lobe shows an encapsulated tumour with some collapse and distortion of the lung around it (*Fig.* 345). The histological appearance of a part is shown in *Fig.* 346, and the endothelial type of cell with vascular channels is well illustrated.

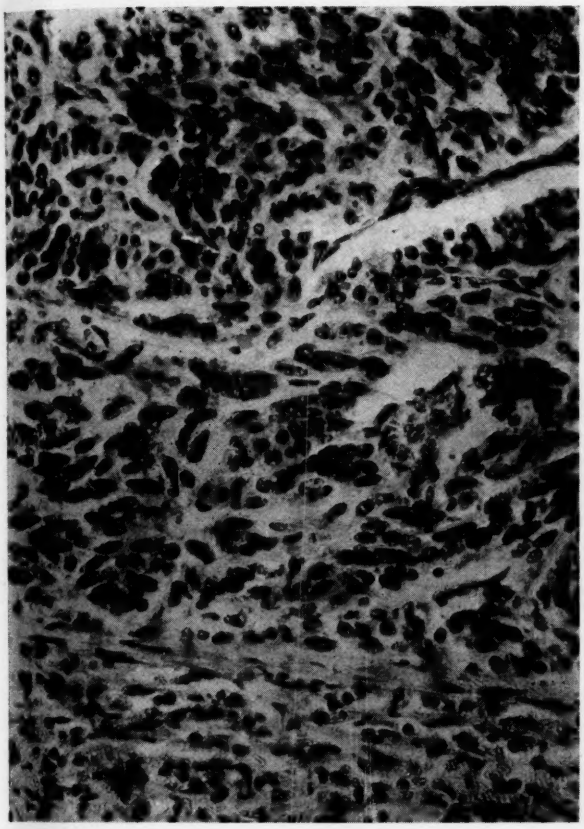

FIG. 346.—*Case* 2. Microscopical section of tumour.

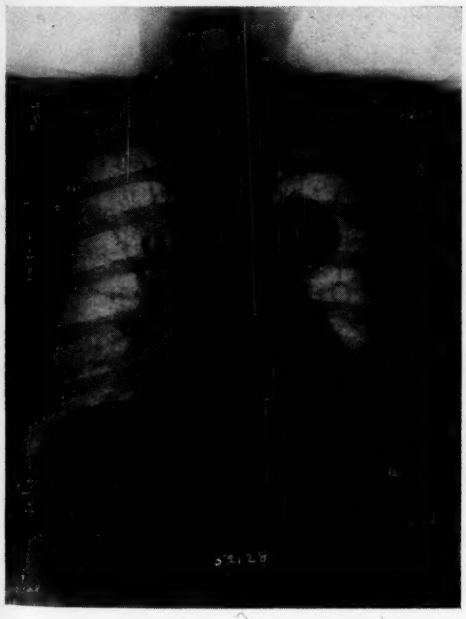

FIG. 347.—*Case* 3. Radiograph of the chest.

Case 3.—N. G., female, aged 56, was admitted to the Brompton Hospital on June 18, 1934, under Dr. Burrell, complaining of loss of weight, malaise, and a constant dull ache in the front of the chest since 1930. Severe pain in the left side of her chest was the chief complaint on admission. She gave a history of an X-ray of the chest in South Africa over two years before, which had showed a tumour at the left hilum.

X-RAY EXAMINATION. — This showed a pyriform opacity in the middle zone of the left lung with regular borders extending out from the hilum (*Fig.* 347). The lateral view showed it to be well anterior to the bodies of the vertebræ. A diagnostic pneumothorax was induced, and the tumour appeared to be within the lung. On July 3 thoracoscopy

FIG. 348.—*Case* 3. Section through the removed lobe and tumour.

was performed but no evidence of secondary deposits or involvement of the lung surface was seen. The lung itself had collapsed well away from the chest wall.

OPERATION.—Operation was carried out on July 25 under intratracheal gas and oxygen anæsthesia given by Dr. Magill. Thoracotomy showed the tumour to be situated in the left

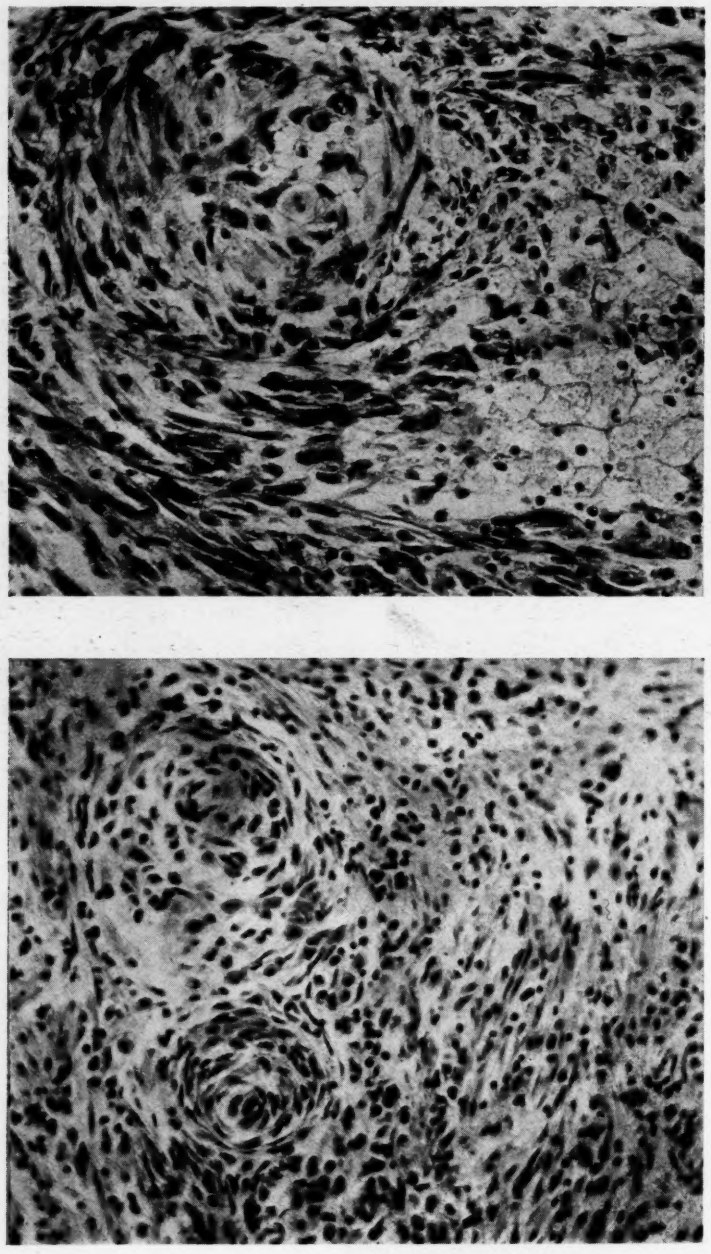

FIG. 349.—*Case* 3. Microscopic sections of the tumour.

upper lobe just free from the hilum, and an upper lobectomy was satisfactorily performed. The chest was closed completely and expansion of the lower lobe obtained, aspiration of fluid being required on two or three occasions.

AFTER-HISTORY.—The patient made an uninterrupted recovery and the pain was completely relieved. She has remained quite well since and X-ray examination shows no evidence of recurrence.

PATHOLOGY.—*Fig.* 348 shows the appearance of the tumour lying in the upper lobe, apparently discrete, and more or less encapsulated by condensation of lung tissue. The microscopical appearance is reproduced in *Fig.* 349, and the tumour cells are seen with a whorled arrangement, from which a diagnosis of endothelioma of vascular type was made.

Case 4.—L. P., female, aged 50, was admitted to a nursing home in May, 1935, complaining of heartburn and occasional abdominal distension. She had had a slight non-productive cough and dyspnœa for two years subsequent to appendicectomy. There was no complaint of thoracic pain.

FIG. 350.—*Case* 4. Antero-posterior radiograph of the chest.

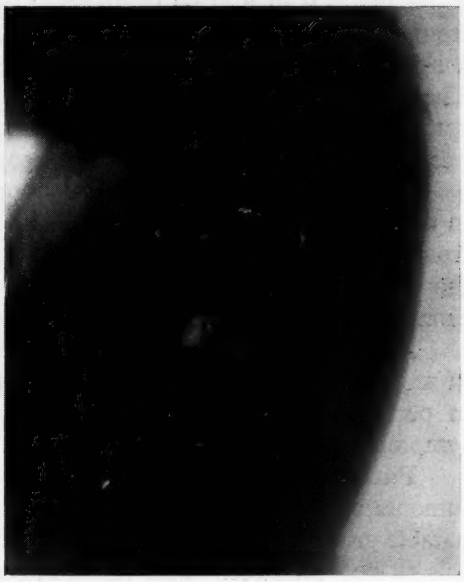

FIG. 351.—*Case* 4. Lateral radiograph of the chest.

Routine barium meal and cholecystography were carried out, in the course of which a shadow was seen in the lower part of the right lung field. Oblique and lateral views showed a tumour, well demarcated and without pulmonary reaction in the surrounding lung, situated in the right lower lobe (*Figs.* 350, 351). Artificial pneumothorax and radiography showed the lung and its contained tumour to be free from the parietes.

OPERATION was carried out on May 15 under gas and oxygen anæsthesia by Dr. Magill. A thoracotomy was performed with division of the sixth and seventh ribs posteriorly. The tumour, filling most of the collapsed lower lobe, was found to be free from the chest wall and with a sufficient space between it and the hilum to ensure complete removal by lower lobectomy. No enlarged glands could be felt in the mediastinum. Right lower lobectomy was performed and an intercostal air-tight drainage left for forty-eight hours.

AFTER-HISTORY.—Convalescence was uninterrupted except for a recurrent attack of *B. coli* infection in the urinary tract, which had also complicated the abdominal operation of two years before. Microscopic section again showed the appearances from which a diagnosis of vascular endothelioma was made.

COMMENTARY

This group of cases is seen to consist of three women and one man whose ages varied from 26 to 58, but whose general physique was notably good, although in

Cases 1 and 3 there were symptoms probably associated with the presence of the tumour over eighteen months and four years respectively. The tumour itself in each case was definitely within the lung, free from the mediastinum and pleura, as confirmed by its successful removal intact by lobectomy, and without mediastinal glandular involvement. In no case was there extension to or involvement of the visceral pleura.

Signs and Symptoms.—Clinical signs were absent in *Cases* 2, 3, and 4, but there was dullness on percussion and weakness of breath-sounds in *Case* 1. These naturally depend upon the lung tissue involved by the growth, almost the whole lower lobe in *Case* 1. Cough was complained of in three of the four cases, but in none was it of a gross character. No patient complained of expectoration apart from the one attack of hæmoptysis in *Case* 2. Three patients complained of discomfort in the chest or upper abdomen, but in only one was there acute pain. The absence of pain is, of course, characteristic of all pulmonary neoplasms until spread has occurred to the chest wall or mediastinum. Dyspnœa was noticed by one patient only and this was not necessarily due to the pulmonary condition.

Radiology.—The radiological appearances in all the cases were characteristic in that the shadow was homogeneous, clear in outline, and was clearly demarcated from the surrounding lung. In *Case* 2 a lipiodol bronchogram was made, and, though no abnormality of the mucous membrane was seen by bronchoscopy, the bronchus itself, after the first subdivision, was definitely distorted and indented.

Recurrence and Metastasis.—Neither recurrence nor metastasis has resulted in any case. *Case* 1, operated upon eight and a half years ago, reports that she is in perfect health, and the others, who have been examined quite recently, are symptomless and radiologically normal.

Pathology.—It is difficult to be absolutely exact in assessing the nature of these tumours or to dogmatize on their histology. Certainly clinically they form a comparable group which at first suggests carcinoma, but microscopic examination shows this to be untenable. The illustrations of the cut lobes show obvious distinctive macroscopic appearances. The tumours are well defined and discrete with more or less encapsulation. Some effusion of blood around and compression of the surrounding lung tissue may also be seen. These factors suggest that if the tumours are malignant it is of low grade and only by their slow growth and mechanical effect do they cause symptoms. Microscopically, the sections were examined by Dr. Atkin, Pathologist to the Brompton Hospital, and regarded as vascular endotheliomata, and this opinion has been confirmed by Dr. W. G. Barnard. As already stated, Adler's opinion was that tumours looking like endotheliomata were almost certainly carcinomata, and this is probably true in many cases, as the great variation in detail and histological appearance of pulmonary carcinomata is well recognized.

Ewing[6] has discussed at length the features of endothelial tumours, and though these vary to some extent with the tissue of origin, certain constant factors emerge, and the present cases conform to these. The character of the cell is mainly polyhedral, though varying with position and surrounding pressure. There is a well-defined cell membrane, clear cytoplasm, and small pale vesicular nucleus with minute multiple nucleoli. The presence of circulatory channels, lymphatic or vascular, is frequent, and, in the sections reproduced, capillaries are numerous and in parts their walls have been formed by masses of tumour cells. Ewing, too, stresses the intimate relation that exists between supporting stroma and tumour cells.

Kettle[7] has discussed the endotheliomata, and his description supports this diagnosis. He indicates the difficulty in clearly establishing the characteristics of the atypical endothelioma, but among the points of importance in the diagnosis are the following: The close relationship of the cells to the blood-vessels; their whorled arrangement, and the absence of any suggestion of a glandular or acinous formation; the presence of giant cells; the tendency on the part of groups of cells to form regular columns of cells two or three layers thick, or of elongated tubules; and the comparative innocence of the tumours. Considerable variation occurs in endotheliomata on account of their origin, and Welsh[8] has, in a brief classification, separated those that arise from surface endothelium from the tubular forms—vascular, lymphatic, and so on. This emphasizes the complete difference of pleural endothelioma—a not uncommon malignant intrathoracic tumour—from the intrapulmonary vascular endothelioma recorded here. While this term is perhaps a little vague, though descriptive and differential, it must be noted that this tumour is not of the angioma type.

Dr. Barnard,[9] to whom we are indebted for the microphotographs, in discussing the microscopic sections, remarks in reference to *Case* 2 on the presence of three types of cell—" spindle cells arranged in some parts in whorls or trabeculæ; plasma cells and lymphocytes; and large vacuolated cells of the fat-granule type." He draws attention to some resemblance to lymphadenoid tissue, which may be derived from endothelium, and observes that the nature of the growth might be confused with a granuloma. In *Case* 3 he describes the cells as " closely packed with scanty protoplasm and large oval nuclei having a distinct chromatin net and chromatin nodes. These cells appear to be forming capillary spaces ".

SUMMARY

Four cases have been described of an intrapulmonary tumour with distinct clinical characters and radiological appearance, successfully treated radically by lobectomy, and having the suggested pathological diagnosis of vascular endothelioma. A search of the literature has failed to reveal any exactly comparable cases.

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RIGHT 'DUODENAL' HERNIA

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INTRODUCTION

THE title 'duodenal hernia' suggests a hernia having an intimate relationship with the duodenum. It is, however, used to describe internal herniæ occurring in the neighbourhood of the terminal part of the duodenum, but the duodenum itself has no special claim to be selected for naming them. Custom has, however, established the name, and we have retained it for the title of this paper. These herniæ are of two types—right duodenal and left duodenal. They are not exceptionally rare. Nagel (1923) collected the records of twenty-nine cases of the right duodenal type, including one of his own, and over one hundred of the more common left duodenal variety.

Duodenal herniæ raise interesting speculations as to their mode of origin. Treitz (1857) was the first to suggest that such herniæ originate in intraperitoneal fossæ, and nearly all subsequent writers have subscribed to his views. Moynihan (1899*) in his Arris and Gale lectures made a careful review of the subject, and concluded that right duodenal herniæ originate in the fossa of Waldeyer and left duodenal herniæ in the fossa of Landzert. It is worthy of note that Moynihan's lectures are on "retroperitoneal hernia". Duodenal herniæ are, however, not all retroperitoneal. Brown (1925) describes a case of intraperitoneal right duodenal hernia, and Sir Astley Cooper's (1807) well-known case was probably of the same kind. An intraperitoneal right duodenal hernia could not have arisen from the retroperitoneal fossa of Waldeyer. Some other explanation must be given to account for these cases.

Andrews (1923) writes, "There is not a dissenting voice to the view that such small peritoneal pouches are the starting points of these enormous herniæ." He draws the ingenious conclusion that "duodenal hernia is a congenital anomaly due to imprisonment of the small intestine beneath the mesentery of the developing colon". Brown (1925) points out that Andrews's view is not tenable because the developing colon could not adhere to the posterior abdominal wall, except by descending to the right loin outside the area of the small intestine. Imprisonment of the small intestine could not occur in the way postulated by Andrews. Andrews has, however, given a list of conditions which are found in duodenal herniæ, and any theory attempting to account for these herniæ must account for the presence of these conditions. The list is as follows:—

1. There is no *vis a tergo* to force contents into the sac of a duodenal hernia. Differential pressures are utterly lacking within the abdomen.

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* Many writers wrongly date these lectures 1906.

2. There are literally hundreds of folds and fossæ in the peritoneal sac of large size, and they are never the sites of hernia.

3. In all but a very small minority of cases reported, the degree of herniation has been total or subtotal. Vogt (1913) reports a case in which such a hernia was found total in an infant.

4. The herniated viscera are never anything but small intestine. Omentum, a viscus found in nine out of ten herniæ at other sites, has never been reported entering the sac. Pybus (1916) reports a case with a few inches of descending colon in the sac.

We record a case of intraperitoneal right duodenal hernia, which forms a uniform series with Sir Astley Cooper's and Brown's cases. We have taken the opportunity of making a careful dissection of the hernia, and we attempt to answer the riddle of its origin.

CASE REPORT

HISTORY.—K., female, Sinhalese, aged 3 months, was brought to the Lady Ridgeway Hospital on Feb. 2, 1937, with a history of persistent vomiting for the last two weeks. The parents stated that the vomit was projected a few feet from the child's mouth and that it was yellow in colour. The child had vomited about twenty times on the day previous to admission. The stools were hard and were expelled with difficulty once a day. Soon after admission to hospital the child vomited bile-stained watery fluid.

ON EXAMINATION.—The child was seen to be well developed for her age. She looked extremely ill. Temperature 99°; pulse 150, poor volume. On inspection of the abdomen a ball-like wave of peristalsis was seen passing from under the left costal margin across the epigastrium and curling downwards on the right to the level of the umbilicus, where it gradually faded away. Every now and then the child moved her elbows and fingers in a convulsive spasm (gastric tetany).

The projectile vomiting and the direction of peristalsis clearly pointed to the fact that the stomach was making vigorous efforts to overcome an organic obstruction. As the vomit contained bile, the obstruction was considered to be below the opening of the common bile-duct, and high up in the small intestine. The curling down of the peristaltic wave to the right of the umbilicus pointed to the dilatation of the duodenum, as well as the stomach. Immediate operation was arranged for, but in a very short time the child was found to be pulseless and the waves of peristalsis had disappeared. No operation could be performed. The child expired soon after.

PARTIAL POST-MORTEM EXAMINATION.—The abdomen was opened. The peritoneal cavity was clean. The stomach was greatly dilated, as were also the first, second, and third parts of the duodenum. The large intestine was collapsed and empty. The terminal coils of the ileum were also collapsed and empty, but the rest of the small intestine from the duodeno-jejunal flexure to these terminal coils of the ileum was enclosed in a thin-walled hernial sac, which lay below the transverse colon. The enclosed coils of intestine could be seen through the transparent walls of the hernial sac. The gut in the sac was of normal colour. The neck of the sac was large, being apparently situated in the upper leaf of the mesentery of the small intestine, below the vascular arch of the superior mesenteric vessels. The hernia could easily have been reduced.

The sac lay below the transverse mesocolon as a pouch the fundus of which pointed downwards and to the left. The terminal coils of small intestine formed a coiled fringe with its mesentery coming off the neck of the hernial sac.

ANATOMICAL FINDINGS

The specimen, as received in the anatomical laboratory, consisted of the abdominal visceral mass, minus the liver and the pelvic organs, together with the peritoneal investments (*Figs.* 352, 353).

The *stomach* is normal in size, form, and position. Its pyloric musculature is not hypertrophied, nor its canal stenosed.

The *duodenum*, on the contrary, is grossly abnormal, especially in size. Its general form and arrangement can be seen in *Fig.* 354, which is a drawing of the specimen from the dorsal aspect. The first part of the duodenum, 33 mm. long,

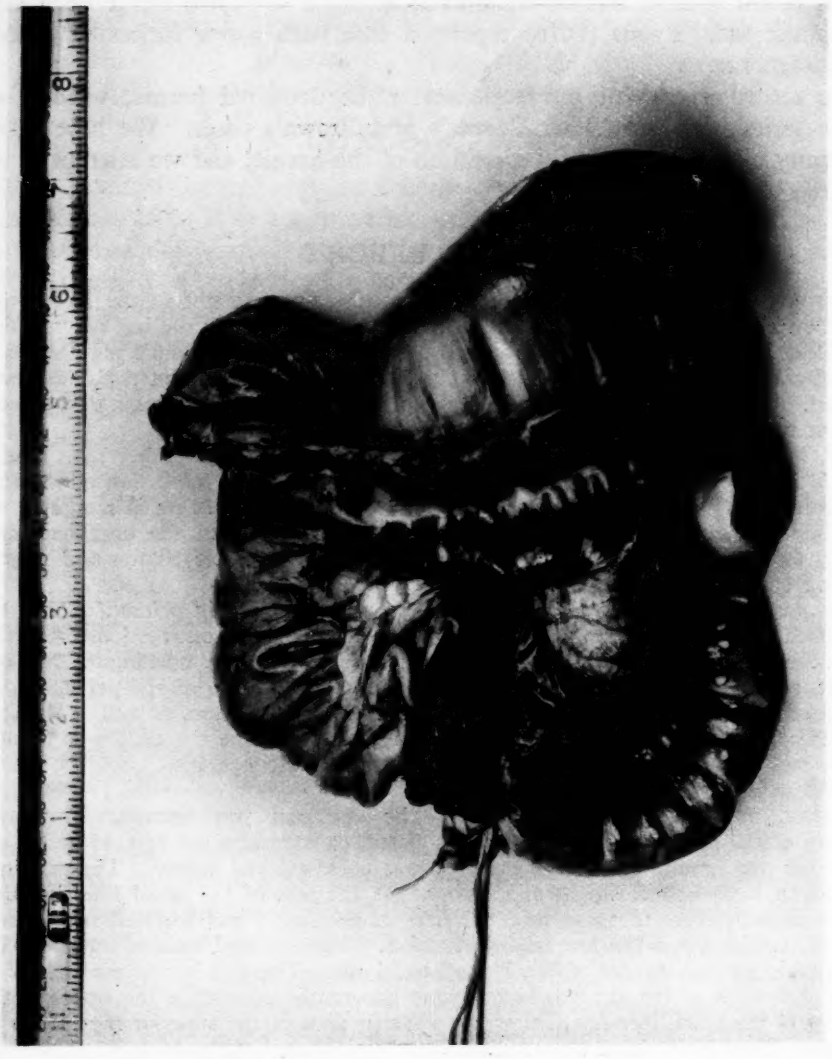

FIG. 352.—Photograph of the specimen from the ventral aspect with the hernia in its original position.

proceeds in the usual direction, but like the rest of the duodenum is markedly dilated. The second part, 80 mm. long, descends vertically to the same level as the ileocæcal junction. The third part is shorter (46 mm.) and proceeds to the left and upwards, and then projects forwards before becoming continuous with the jejunum. All three parts have an average transverse diameter of 32 mm. The

whole of the duodenum lies behind the peritoneum, but dilatation causes it to bulge forwards, so that it possesses a much more complete serous investment than usual, especially in its first and third parts.

The great dilatation of the duodenum causes it to occupy a very much larger amount of space on the posterior abdominal wall than usual. The second part, in particular, is so enlarged, especially to the right, that it prevents the ascending

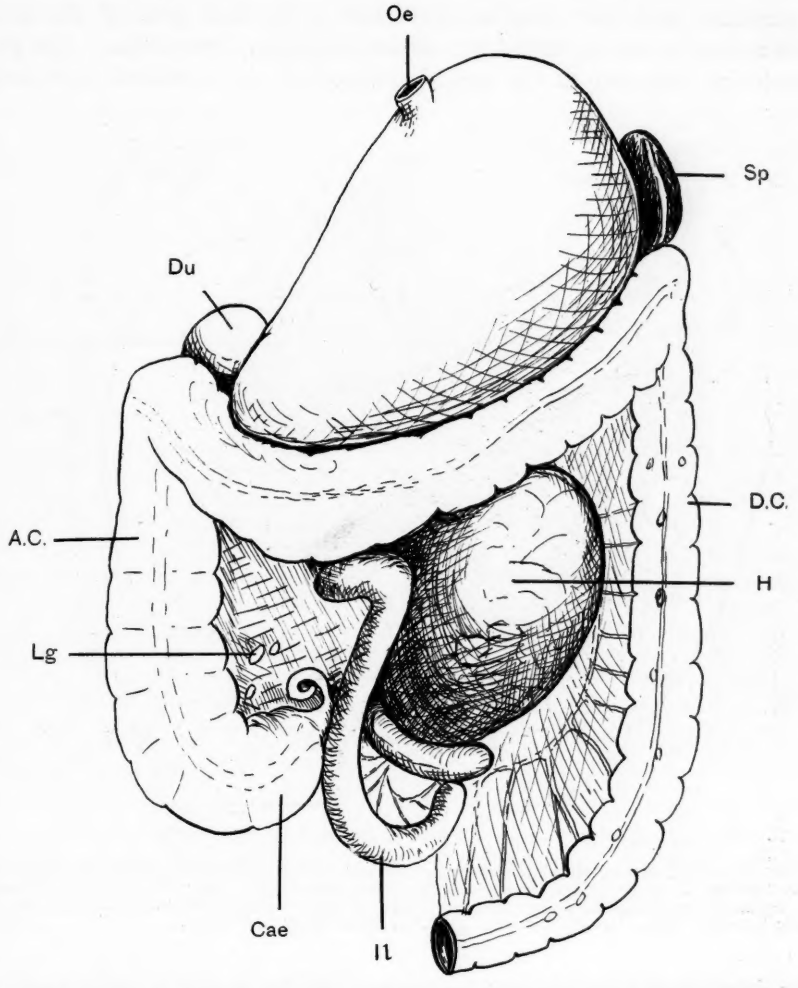

FIG. 353.—General view of the abdominal viscera from the ventral aspect (compare with *Fig.* 352). Oe, Œsophagus; Sp, Spleen; Du, Duodenum; A.C., Ascending colon; D.C., Descending colon; Cae, Cæcum; Lg, Lymph-gland; H, Hernial sac; Il, Free loop of ileum.

colon from occupying its normal position on the abdominal wall. The colon lies on the duodenum instead. The third part of the duodenum lies lower down and farther to the left than normally.

The *pancreas* is somewhat altered in shape as a result of the duodenal abnormality. Its head occupies the usual position in the duodenal concavity, but lacks the normal rounded outline. The body and tail are elongated and placed obliquely

instead of transversely, ascending on the left to gain the hilum of the spleen. The body has the usual prismatic form; and the whole gland is completely retroperitoneal. The common bile-duct and pancreatic duct have normal relations. No accessory duct was noted. The splenic vessels have the usual relations to the pancreas, and in the dorsal view (*Fig.* 354) the inferior mesenteric vein can be seen ascending towards the angle between the body and head of the pancreas, where it unites with the splenic vein. The peritoneum covering the lower half of the body of the pancreas and that covering the front of the last part of the duodenum sweeps to the left as the anterior layer of the descending mesocolon. No peritoneal fossæ could be detected in the neighbourhood of the duodenal termination.

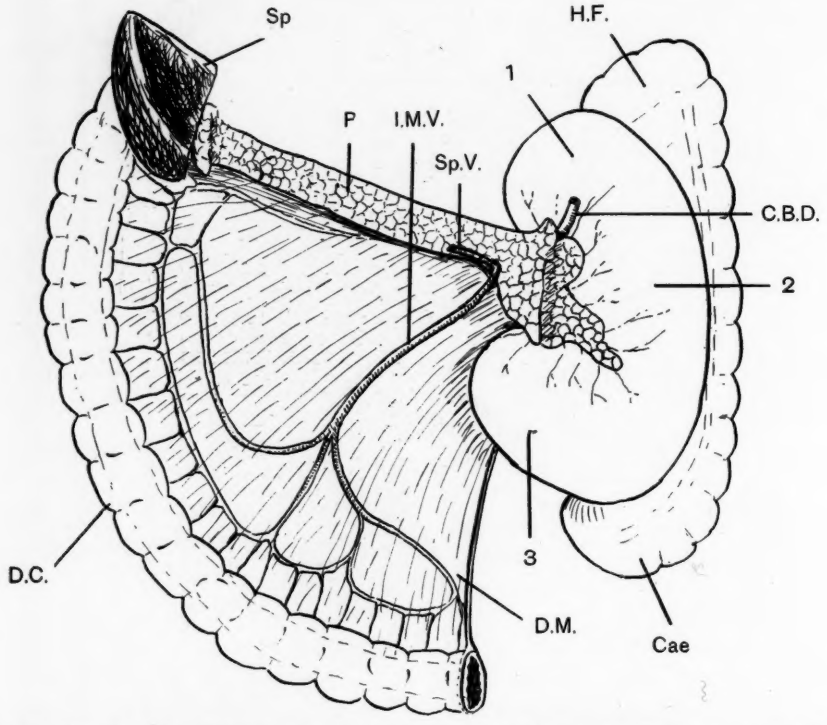

FIG. 354.—Part of the abdominal viscera viewed from behind to show the dilated duodenum and the stretched pancreas. 1, 2, 3, First, second, and third parts of the duodenum; Sp, Spleen; P, Pancreas; Sp.V., Splenic vein; I.M.V., Inferior mesenteric vein; C.B.D., Common bile-duct; Cae, Cæcum; H.F., Hepatic flexure; D.C., Descending colon; D.M., Descending mesocolon.

The *jejunum* arises from the upper part of the anterior surface of the third part of the duodenum, and is normal in calibre. It proceeds ventrally and dives almost at once into a huge hernial sac containing all the rest of the small intestine, with the exception of the terminal few centimetres of ileum, which are free. The jejunum enters at the right aspect of the pedicle of the sac. This pedicle is formed by a thickened peritoneal ligament carrying the superior mesenteric vessels after they have given off their pancreatico-duodenal and mid-colic branches.

The *hernial sac* is an oval one occupying the left part of the centre of the abdomen. It has a cranial and a caudal pole, dorsal and ventral surfaces, and left and right borders. The length between the poles is 60 mm., the breadth

from right to left 41 mm., and antero-posterior depth 40 mm. The sac is covered by smooth, transparent peritoneum, through which the coils of small bowel can be seen. The covering consists of two layers separated by areolar tissue. The orifice of the sac measures 18 mm. long by 6 mm. across. It is situated on its right border, and can only be seen by displacing the sac in an upward and leftward direction (*Fig.* 355). From this aspect the entrance of the jejunum into the sac is obscured by the thickening of the peritoneum of the pedicle, but the emergent loop of ileum is readily visible taking exit from the upper right part of the opening. It appears to be capable of withdrawal partly, if not completely,

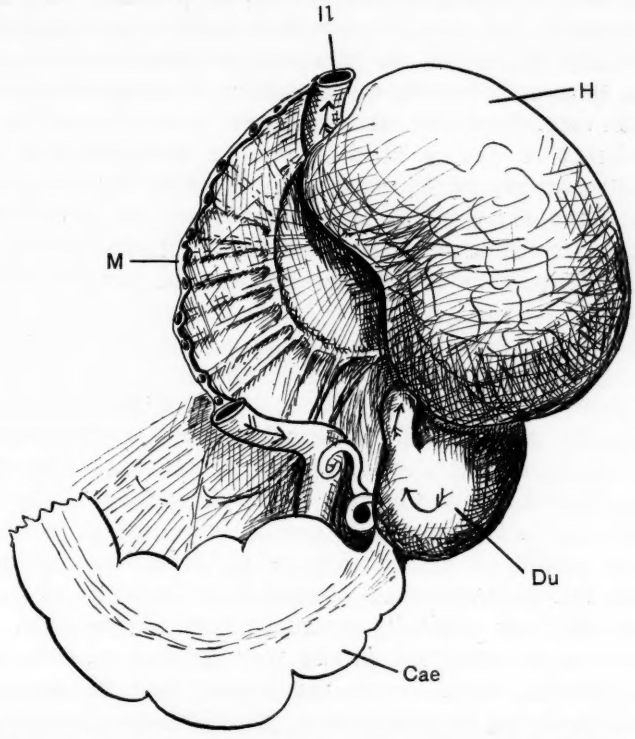

FIG. 355.—Part of the abdominal viscera from the ventral aspect. The hernial sac has been turned upwards and to the left to show its orifice. Its caudal pole is now at the top of the figure. H, Hernial sac; Il, Emergent loop of ileum; Du, Termination of duodenum with commencement of jejunum entering the hernial sac; M, Cut edge of the mesentery of the free portion of the ileum containing an arterial arcade derived from the superior mesenteric artery, and forming the boundary of the orifice into the hernial sac; Cae, Cæcum.

from the sac. The orifice is reniform in outline, with cranial and caudal horns and right and left borders. It lies half an inch anterior to the posterior abdominal wall. The right boundary is formed by the mesentery of the free portion of ileum. The left is occupied by the bunched mesentery of that portion of the intestine continued in the sac. The pedicle containing the mesenteric vessels forms the cranial boundary of the opening. The right wall of the opening carries that portion of the mesenteric artery that supplies the terminal loops of ileum. By moving the sac about, it becomes clear that it only occupies the left half of the abdominal cavity by virtue of falling on its side as a result of the weight of its contents, besides having undergone some degree of rotation on its pedicle. By

replacing it in its original position, it is evident that its left border is morphologically ventral, and its anterior aspect originally looked towards the right. The same process brings the orifice into a position in which it looks caudally and to the left; so that, although the hernia would fall, as most of them do, into the class of 'left duodenal hernia', it is morphologically a herniation towards the right. This point will be brought out more clearly in the discussion which follows.

The *remaining parts of the alimentary canal* may be briefly dismissed. The ileocæcal junction lies in the lower right portion of the abdominal cavity. The cæcum is large, and of the usual infantile type. Its apex points medially and somewhat upwards, and is prolonged into a long, much coiled vermiform appendix. This latter is provided with a small mesentery throughout its length—a product of the (morphologically) left leaf of the mesentery of the terminal ileum, and coming off it at a point 35 mm. below the caudal margin of the hernial orifice. From the cæcum the colon ascends on the anterior aspect of the duodenum till it reaches the pylorus, whence it takes a bend to become the transverse colon. This is provided with a mesentery in the usual way. A splenic flexure is formed, and the descending colon proceeds in the usual manner into the pelvis, but is provided throughout with a mesocolon. The ventral leaf of this mesocolon is continuous, towards the midline, with the peritoneum covering the last part of the duodenum.

DISCUSSION

From the above account of the hernia, it is evident that it falls into the category of what have usually been termed 'duodenal herniæ'—an undesirable name, but, as it is in current use, it must for the present be adopted. Moynihan (1899) has classified all the internal herniæ arising in the neighbourhood of the duodeno-jejunal flexure as 'left' and 'right' duodenal herniæ, according to their position in the belly. Our case would thus, according to its definitive position, be a 'left' duodenal hernia, but its position has already been explained as due to a rotation of a hernial sac that was originally protruded towards the right.

In our opinion this grouping is not very satisfactory, since it is concerned with the final position taken up by the hernial sac; no account is taken of changes of position during its enlargement, possibly because they were not known to occur.

Much energy has been expended by previous writers on this subject, since the time of Treitz (1857), in efforts to derive duodenal herniæ from one or other of the nine peritoneal fossæ that have been found to exist in the neighbourhood of the duodeno-jejunal flexure. Treves (1885, 1899) believed that all forms of duodenal hernia were derived from the inferior duodenal fossa, or duodeno-jejunal, as he called it. Moynihan disposed of most of the fossæ as possible precursors of hernial sacs, but gave good reasons for supposing that the paraduodenal fossa, or fossa of Landzert, was the predecessor of the sac of a left duodenal hernia. The main argument in favour of this was the presence in the neck of such hernial sacs of the inferior mesenteric vein accompanied by the ascending branch of the superior left colic artery, and "the fold containing this vein is the plica vasculosa, and the fossa bounded by such fold is the paraduodenal fossa". Moynihan has less to say about 'right' duodenal herniæ, believing them to be rare compared with the left variety; but he believed that the fossa of Waldeyer was the

precursor of such a hernia. Most subsequent writers have subscribed to this view, Andrews (1923) being a notable exception. In this instance the neck of the hernial sac is related to the stem of the superior mesenteric artery, which occupies its anterior margin.

In our case, although the final position of the hernial sac is to the left, the neck of the sac has no relation whatever to the inferior mesenteric vein. It has, however, a relation to the superior mesenteric artery, after the latter has given off its pancreatico-duodenal and middle colic branches. The true relations of the hernia at the time of its earlier history can be best understood by studying that portion of the small intestine and its mesentery which is not contained in the hernial sac. Examination of this reveals that the apparent caudal pole of the hernia is its morphologically cranial pole, and that the leftward projection of the sac is entirely due to its having rotated clockwise on its own pedicle, and then fallen over to the left from its own weight. It is clear, therefore, that the original projection was to the right.

The next question is whether the fossa of Waldeyer was the precursor of the sac; or, alternatively, was the prominence caused by a bulging of the layers of the mesentery itself? The fossa of Waldeyer is situated at the very root of the first part of the mesentery, and its cavity proceeds to the right and posteriorly. Intestine getting into it would tend to proceed retroperitoneally. That has not happened in our case. On the contrary, the sac has obviously enlarged by forcing the layers of the mesentery itself towards the right, the pouch commencing originally, no doubt, behind the stem of the superior mesenteric artery, where there is no reinforcement by the rami intestini tenuis. This view is supported by the fact that: (1) The representatives of both layers of the mesentery and also the intervening extraperitoneal areolar tissue were discovered on the wall of the sac; (2) The wall of the sac is free all over its periphery except at the pedicle; and (3) The mouth of the sac is not flush with the structures on the posterior abdominal wall at the root of the mesentery, but is half an inch farther forwards.

But whether the fossa of Waldeyer is the precursor of a right duodenal hernia or not, or whether, as is probable in our case, the hernia arises from a congenital weakness or potential pouch on the mesentery itself, certain general principles appear to be applicable: (1) The contents of such herniæ are always small intestine, and nothing else—e.g., omentum is never encountered. (2) The hernia always involves the whole, or nearly the whole, of the small intestine. (3) A large vessel, connected at its peripheral end with a mobile portion of gut, is found in the neck of the sac. Possibly traction exerted by such a vessel is the original force causing the orifice of a pre-existing fossa or pouch to gape, and so admit a small loop of small intestine. This last argument explains why the fossæ of Landzert and Waldeyer are the only possible peritoneal fossæ in this region that can act, if any fossa ever does act, as a potential hernial sac. They are the only ones which have a large vessel related to them. A loop once admitted, the rest of the small intestine enters as a result of its own peristaltic action, and not by any *vis a tergo*, which cannot be postulated in the case of internal, as it can with external, herniæ. Omentum could not do this.

As regards 'mesenteric' herniæ, of which we believe ours to be an example, Moynihan averred that they did not exist. The only case he knew of was Astley-Cooper's, and he considered the description of this too vague to be decisive.

Others, however, have since been recorded—e.g., Brown (1925)—and mesenteric hernia is now considered to be a rare, but definite, entity. The resulting hernia, however, is so similar to that believed to be produced by herniation into the fossa of Waldeyer that the two may be considered the same from the surgical point of view. Actually a right duodenal hernia into the fossa of Waldeyer is a mesenteric hernia at the *root* of the mesentery (i.e., it arises in the angle between parietal and mesenteric peritoneum), whereas a true mesenteric hernia is one in which the neck of the sac lies more peripherally, i.e., opening on the left side of the mesentery. There seems to be no satisfactory reason why any part of the mesentery should not be involved, but actually it always appears to be the upper part near its root. The entering intestinal loop is therefore always the first loop of jejunum, and peristaltic action speedily effects the entry of all or nearly all the remainder of the small bowel.

An important point is that all mesenteric herniæ are, like those into the fossa of Waldeyer, of the ' right duodenal ' type. This is due to the anatomical disposition of the mesentery and its contents—the bulk of the small intestine lies to the left of the stem of the superior mesenteric artery; and herniation will tend therefore to proceed from left to right.

The duodenal anomalies in the present case are, of course, easily explained as due to stasis in the herniated part of the small intestine. The duodenum is thus forced to take up more room on the posterior abdominal wall, and this, in turn, prevents the descending mesocolon from disappearing by fusion with the parietal peritoneum of the left half of the posterior abdominal wall. The persistent descending mesocolon is thus the effect of, and not, as is usually explained, one of the contributory causes of congenital, duodenal hernia.

SUMMARY AND CONCLUSIONS

1. An example of a rare form of hernia has been reported on and described in detail.

2. The specimen falls into the category of ' duodenal ' hernia as usually understood, but reasons have been given for regarding this name as an unsuitable one.

3. Although occupying in its definite position the left half of the abdomen, and therefore falling into the class of ' left duodenal herniæ ' of Moynihan's classification, reasons have been given for regarding it as a twisted ' right duodenal hernia '.

4. The role of the fossa of Waldeyer in the production of right duodenal herniæ has been discussed, and applied to the present case.

5. Reasons have been given for assuming that the present hernia did not commence in a fossa on the posterior abdominal wall at all, but in one on the side of the mesentery.

6. Mesenteric herniæ and herniæ into the fossa of Waldeyer are two types of one and the same process, both of which have hitherto been treated as ' right duodenal hernia '. The difference between them is only a matter of slight difference of position of the site of origin; the final effect is much the same in both.

7. The view has been advanced that the mouths of small congenital peritoneal fossæ may be caused to gape by traction on the stems of vessels closely related to them; more especially of vessels passing to highly mobile sections of gut. It is

significant that the only fossæ subjected to such influences are (*a*) the fossæ of Landzert and Waldeyer, and (*b*) hypothetical congenital pouches in the mesentery; and that these are the only ones so far proved to be associated with hernia formation.

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TWO CASES OF CONGENITAL MICROCOLON*

By J. B. EWING and W. E. COOKE, Wigan

INCIDENCE

Congenital narrowing of any portion of the intestinal tract of a degree sufficient to cause symptoms is uncommon. The rarity may be gathered from the figures given by Theremin[1] (1877), who quotes the results of 111,451 post-mortems in Vienna and 150,000 in Leningrad. Congenital narrowing was found twice in the Vienna series and nine times in the Leningrad. Clogg[2] (1904) gives the position of the stenosis in 181 collected cases: the jejunum and ileum were affected in 104, the duodenum in 69, and the colon in 8 cases. Greig[3] (1925), in a review of the subject, remarks, "probably about 5 per cent of all cases of intestinal stenosis occur in the great intestine". From the above, the incidence of congenital microcolon would appear to be 1 in about 500,000 post-mortems. The following are reports on two cases seen by us within twelve months. Both were diagnosed, one at operation for intestinal obstruction, the other before operation by one of us (J. B. E.).

CASE REPORTS

Case 1.—L. P., aged 3 days, a male born at term, was a first child. The father was aged 32 years and the mother 27, and both came of healthy stock. The pregnancy and labour were normal. The child was born at 5 a.m. on May 22, 1936; it passed a comfortable day, but during the night became restless, cried, refused its feed, and vomited. It was then noticed that it had passed urine but not fæces. Vomiting became more frequent, the vomit consisting of large quantities of greenish fluid, and the abdomen was distended. On admission to hospital the child weighed 6 lb. and was obviously very ill. The abdomen was tympanitic, and a mass was palpable on the left side. Constipation had been absolute since birth. A rectal examination revealed nothing abnormal.

Operation.—A right paramedian muscle-splitting incision was made. A bluish-coloured distended loop of small intestine, which contained material of putty-like consistence, presented. This was followed downwards, and it was noted that, for no apparent reason, as the lower end of the ileum was approached the bowel became smaller and its contents firmer. The ileocæcal region was brought into view and the condition of microcolon was at once apparent. The ileocæcal valve, cæcum, and the entire colon were minute, firm, fairly thick-walled, but empty. An enterostomy was rapidly carried out and the abdomen closed. No drainage took place from the tube and the child died on May 25, 1936.

Case 2.—A. B., aged 3 days, was a male born at term after a normal pregnancy and a normal labour. The father was 30 years of age and the mother 25 years, both of healthy families. The child was their first, and was born at 6 a.m. on Jan. 28, 1937. On the morning of Jan. 29 the child vomited, at first small amounts of greenish fluid at irregular intervals, increasing later to large amounts every few minutes. Constipation was absolute and the abdomen distended. Urine was passed normally.

On admission to hospital the child weighed 6 lb. The abdomen was tympanitic and vague masses could be palpated. A rectal examination revealed nothing abnormal. In view of the previous case a diagnosis of congenital microcolon was made.

Operation.—The story of the operation and subsequent history is a repetition of *Case* 1. The child died on Jan. 31, 1937.

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* From the Royal Infirmary, Wigan.

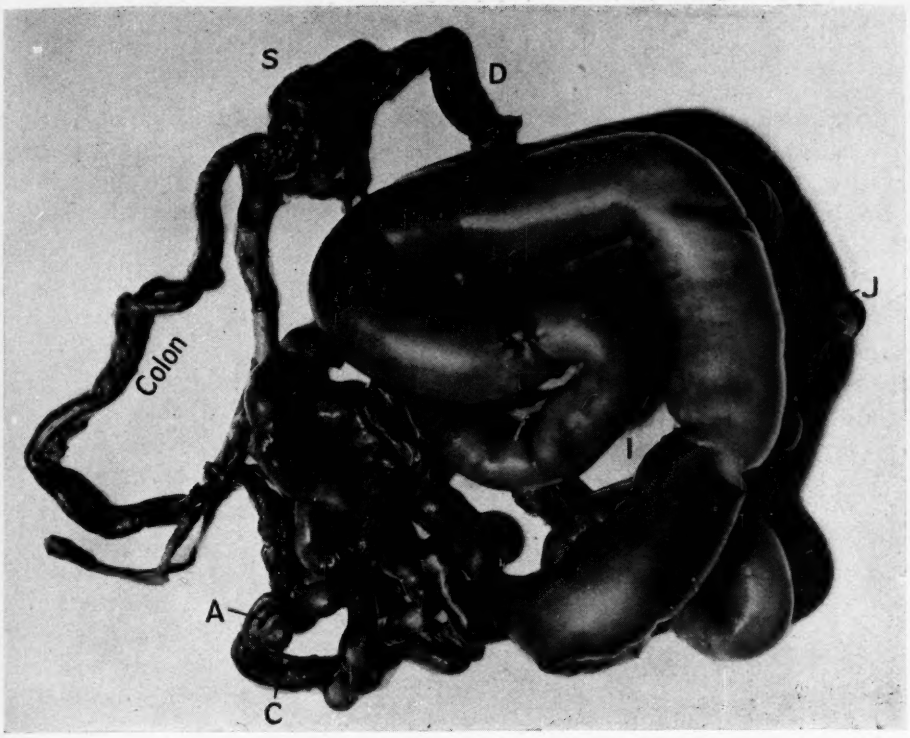

FIG. 356.—*Case* 1. Photograph of the intestinal tract. S, Stomach; D, Duodenum; J, Jejunum; I, Ileum; C, Cæcum; A, Appendix: R, Rectum (in *Fig.* 357).

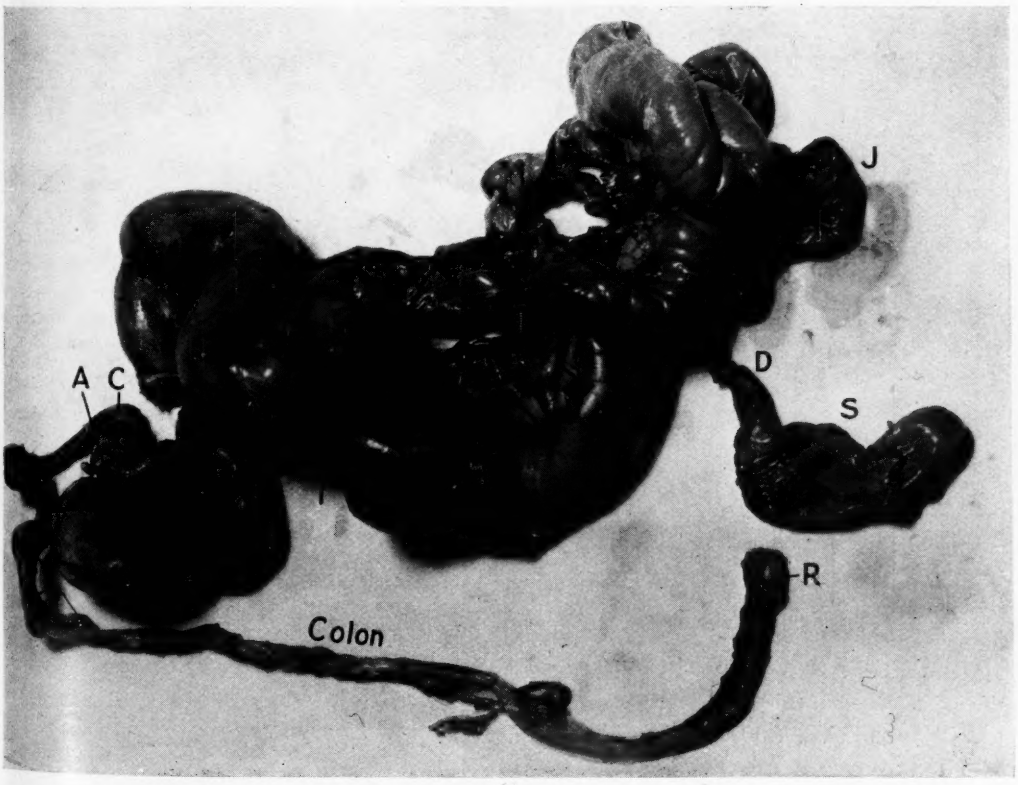

FIG. 357.—*Case* 2. Photograph of the intestinal tract. Lettering as *Fig.* 356.

PATHOLOGY

As mentioned above both were first children, males aged 3 days at death, and both weighed 6 lb. on admission to hospital after much vomiting and dehydration. In neither case were there peritoneal bands—such as cystico-colic ligaments—or any evidence of intra-uterine peritonitis, or any developmental abnormality of the peritoneum present.

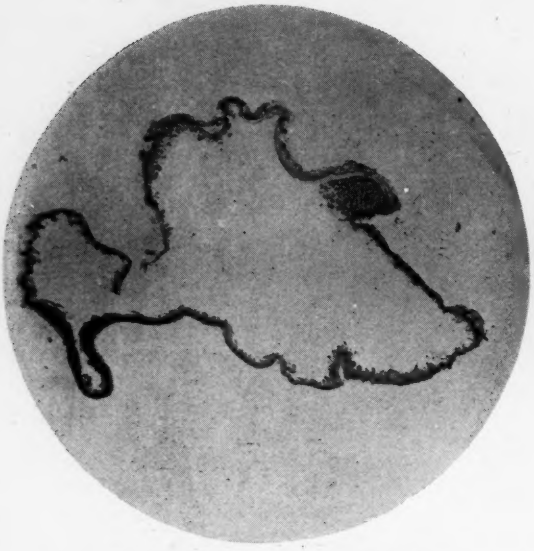

FIG. 358.—*Case* 1. Section of the jejunum showing the normal but stretched wall. (× 5.)

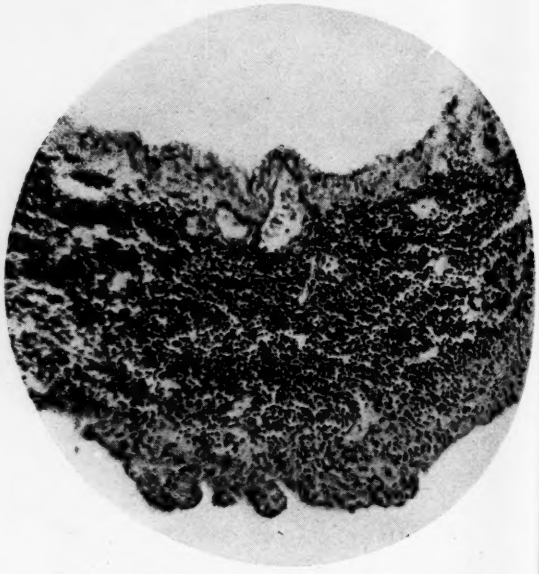

FIG. 359.—*Case* 1. Wall of jejunum showing normal amount of lymphoid tissue. (× 100.)

FIG. 360.—*Case* 1. Section of ileum showing distension of the gut by inspissated meconium. (× 5.)

FIG. 361.—*Case* 1. Wall of the ileum showing hypertrophied muscular coat. (× 100.)

In *Case* 2, however, the gut had not rotated and the colon lay on the right side.

The appearances are seen in *Figs.* 356 and 357, and the conditions of the intestine were identical, except for a slight difference in the length. In *Case* 1 the length of the duodenum, jejunum, and ileum was 211 cm. and the colon 48 cm.; in *Case* 2 the duodenum, jejunum, and ileum measured 220 cm. and the colon 38 cm. The following remarks relate to *Case* 1, but are applicable in all particulars to *Case* 2. The stomach (S) and pylorus were normal. The duodenum and jejunum (D and J) and proximal part of the ileum were empty, flaccid, and wrinkled, suggesting previous dilatation. Microscopically (*Fig.* 358) the muscular wall appeared normal, but stretched. The lymphoid tissue was normal in amount (*Fig.* 359), but the mucosa had undergone considerable post-mortem change. This flaccid portion was immediately followed by a tensely distended ileum (I) 2 cm. in diameter, filled with partially inspissated green meconium. The distension increased until the diameter was 3 cm. and then gradually diminished to 9 mm. as the cæcum was reached, and the meconium became more inspissated and harder (*Fig.* 360). Microscopically the muscular wall of the ileum (*Fig.* 361) was hypertrophied, but the mucosa although compressed was normal. In *Fig.* 362 the termination of the ileum, containing dried green meconium, and the cæcum are seen, together with three sections of the appendix. A glance at *Fig.* 356, A, will show how the section was taken. The ileocæcal valve was patent, but the cæcum contained merely a trace of meconium, the rest of the contents being almost entirely cell debris. The appendix did not contain meconium. The colon (*Fig.* 363) measured 5·5 mm. in its external, and 3·1 mm. in its internal, diameter. It was, in its entire extent, completely devoid of meconium, the contents being a white pultaceous mass of cell debris and mucus. The mucosa was normal, but the muscular coat appears hypertrophied (*Fig.* 364).

FIG. 362.—*Case* 1. Section through the termination of the ileum, cæcum, and appendix, at *Fig.* 356, A. The cæcum contains mucus, cell debris, and a trace of meconium. (× 5.)

FIG. 363.—*Case* 1. Section of the colon, showing normal mucosa, but with some hypertrophy of the muscular layer. (× 5.)

The photomicrographs were taken of sections of *Case* 1, but *Case* 2 did not differ in any way in histological structure. The intestinal tracts in these cases were patent

throughout; not the slightest constriction was present in any part. Even the colons, although small, had good lumina.

FIG. 364. *Case* 1. Wall of colon. The muscular coat appears hypertrophied. (× 100.)

CAUSATION

Many theories have been advanced to account for the condition, but most of them may be dismissed in the present cases.

The blood-supply to both colons was perfectly normal—the arteries were normal in size, there was no endarteritis, and the veins were patent. There were no peritoneal bands nor any abnormalities in the mesentery. The ileocæcal openings were patent, and meconium ileus and absence of *vis a tergo* are ruled out by the appearances—macro- and microscopical—of that part of the gut. The theory which covers the facts was advanced by Greig, who suggested that congenital microcolon was caused by the lack of relaxation—an achalasia—due to a defect in the autonomic nervous mechanism. The anatomical structure is normal, but meconium has not passed into the colon because it has never opened to receive it. Contractions of the wall of the ileum continue, and hypertrophy of the muscular coat results. The persistent contraction, or rather the lack of relaxation, of the colon accounts for the hypertrophy of its muscular coats. Distally, the rectum is normal and would function, as evidenced by the finger being gripped on examination, but it never receives meconium owing to the condition of the colon.

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CHRONIC REGIONAL COLITIS

By T. G. ILLTYD JAMES, London

Tumour-like inflammatory masses in the intestine occur most frequently in the lower ileum, and produce symptoms and signs of inflammation or obstruction according to the stage of the lesion. Considerable attention has been focused on the subject in the last decade, nearly all the contributions dealing with involvement of the terminal ileum. In a few reports, other parts of the gastro-intestinal tract have been affected. Isolated involvement of part of the colon, however, is distinctly unusual, and for this reason the following case is reported.

CASE REPORT

History.—T. A. C., a youth aged 19, was seen on March 1, 1937, complaining of colicky abdominal pains of seven weeks' duration. The pains were paroxysmal, of a few minutes' duration, and appeared to be aggravated by meals. During the attacks there was a desire to defæcate. For some weeks before this he had had a dull ache in the left side of the abdomen. On two or three occasions he had passed some bright red blood in the stools. He had lost a good deal of weight since the onset of his illness. His previous history revealed no significant features.

On Examination.—He was a thin young man weighing 6½ st. and looking rather emaciated. The abdomen was a little distended and there was a fullness to the left of the umbilicus. There was tenderness in the epigastrium and on the left side of the abdomen, where a firm slightly movable mass could be felt extending in the line of the large intestine from mid-epigastrium to the left iliac fossa. Rectal examination was negative. No other abnormality was found on physical examination.

Blood.—

Blood-count :—		
Red cells	5,340,000	
White cells	12,570	
Neutrophil leucocytes	74	per cent
Lymphocytes	23	per cent
Hæmoglobin	81·9	per cent
Colour index	0·7	

Wassermann Reaction.—Negative.

Mantoux Test.—Negative.

Urine.—No abnormality.

Bacteriological Examination.—Serum agglutinations were negative for *B. typhosus, B. paratyphosus A and B, B. abortus, and M. melitensis.*

Stools.—The stools showed mucus, pus, and bright red blood on a few occasions. On most days they appeared normal to the naked eye, but occult blood was persistently present. No tubercle bacilli or other abnormal organisms were found on repeated examination. Sigmoidoscopy revealed no abnormality.

X-ray Examination.—A radiograph of the lungs showed no abnormality. A barium enema revealed a narrowing of the gut involving the distal part of the transverse colon, the whole of the descending and iliac portions, and the upper part of the pelvic colon, with some mucosal irregularities (*Fig.* 365). Although in the descending colon the lumen was extremely narrow the enema had found its way into the cæcum. The radiological findings were similar on a subsequent examination.

Progress.—During the period of investigation, he had many attacks of spasmodic lower abdominal pain. The pains were aggravated by eating, and appeared at irregular intervals,

the longest period of freedom being nine days. There was no visible peristalsis during the attacks, but there was moderate abdominal distension. No alteration occurred in the size of the mass during the four weeks he was under observation. There was occasionally a mild diarrhœa—usually the bowels were open two or three times a day. There was a low-grade irregular temperature—never higher than 102° F. Afebrile periods coincided with freedom from pain.

Although he had gained 2 lb. in weight with an improvement in his general condition, the persistence of the symptoms and signs made operative interference advisable. The history, physical signs, and radiological findings were similar to those in the cicatrizing inflammatory lesions of the small gut described by

FIG. 365.—Radiograph of the colon after barium enema.

Crohn,[1] and a pre-operative diagnosis of regional colitis was made.

OPERATION.—Laparotomy was performed on March 31, 1937. A small amount of serous fluid was found in the peritoneal cavity. The large gut, from the distal part of the transverse portion to the upper part of the pelvic colon, was firm and rubbery and two or three times the normal size. The great omentum was lightly adherent to the affected part, and the peritoneal surface was red and injected. The subperitoneal fatty nodules of this region of the intestine were swollen and firm. The mesenteries at the upper and lower ends were thickened and œdematous, and there

FIG. 366.—The specimen removed at operation.

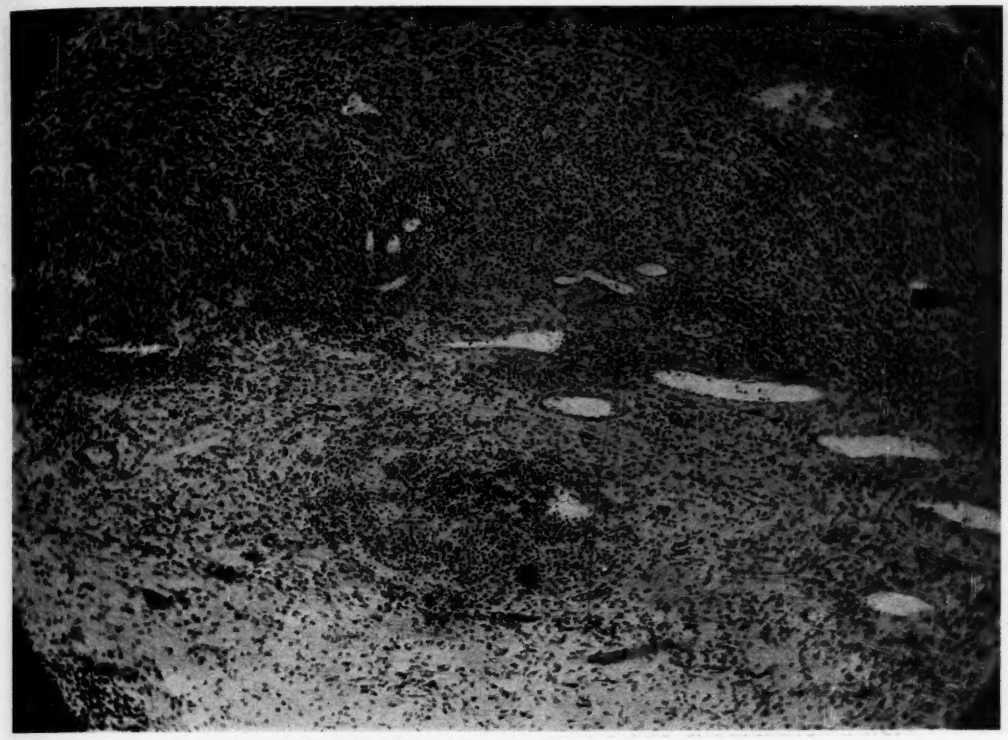

FIG. 367.—Section through submucous layer. (× 65.)

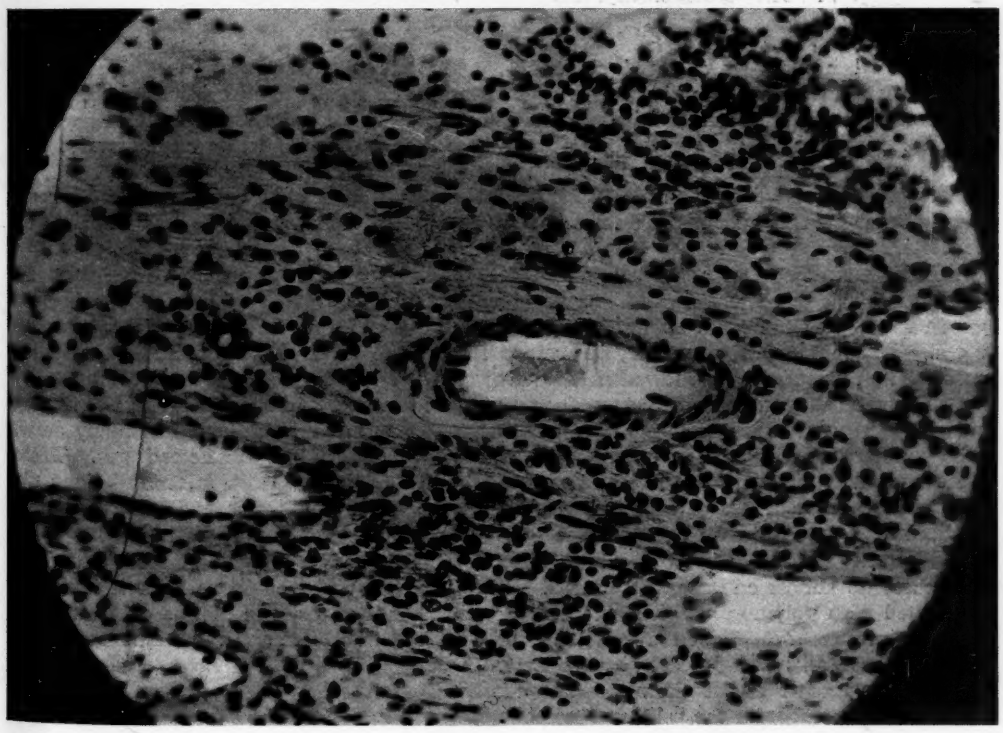

FIG. 368.—Section through submucous layer. (× 240.)

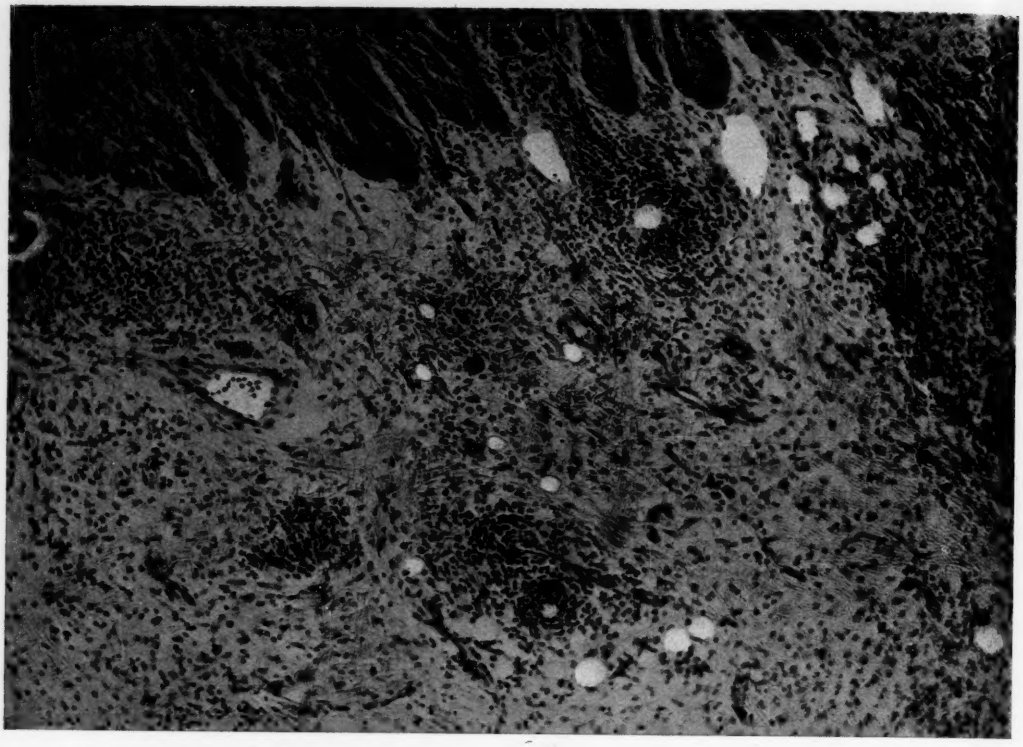

FIG. 369.—Section through serous and outer part of muscular coat. (× 85.)

were several moderately enlarged cherry-like lymphatic glands close to the affected gut. There was sharp demarcation between the unaffected and the diseased portion of the bowel. The remainder of the small and large gut was normal. The appendix was not inflamed.

Resection of the large gut was performed—two inches above and below the diseased part—with end-to-end anastomosis and a cæcostomy as a safety-valve.

Convalescence was uneventful. He was discharged from hospital one month after operation. Three months later his general condition had vastly improved and he had gained 14 lb. in weight.

DESCRIPTION OF THE SPECIMEN (*Fig.* 366).—The specimen measured 15 in. in length. The lumen was extremely narrow, admitting only a medium-sized probe. On opening the gut in its long axis the wall was found considerably thickened—the maximum thickening being 2 cm. The submucous, muscular, and serous layers were all involved, especially the serous coat. The muscular layer showed marked hypertrophy.

The mucous membrane was atrophic and pale, with numerous superficial ulcers of varying size covered with flakes of lymph-like material. The ulcers had coalesced in many areas. The pallor of the mucosa was in marked contrast to that of the unaffected gut. There were several firm enlarged lymphatic glands—pinkish in colour from injection—along the mesenteric border of the gut. The mesentery at the upper and lower ends was thickened and œdematous.

HISTOLOGY (*Figs.* 367–369).—The mucous membrane is ulcerated and the glandular structure has almost entirely disappeared. Together with the submucous layer it is thickly infiltrated with polymorphs, histiocytes, eosinophils, lymphocytes, and plasma cells. Similar cells are present throughout the muscular and serous coats. Here and there amongst aggregates of these cells well-formed giant cells are found.

The lymphatic glands show reticulo-endothelial proliferation with giant cells and infiltration throughout with the cells enumerated above.

COMMENTARY

This case is an example of chronic non-specific inflammation of the intestine. The condition was established as a clinical and pathological entity by Moschowitz and Wilensky[2] in 1923. They described three cases involving the large gut and one involving the cæcum and the ileum. Prior to this, the condition had been lost among a large group of miscellaneous inflammatory lesions, although Moynihan[3] discussed the importance of simple inflammatory tumours of the intestine in 1907, and Dalziel[4] in 1913 was aware of an entity which he described as " chronic interstitial enteritis ". Little attention was focused on the condition, however, until 1932, when Crohn, Ginzberg, and Oppenheimer[1] gave a very detailed account of 14 cases affecting the terminal part of the small intestine, which they termed " regional ileitis ".

Several contributions have appeared since, but very little has been added to our knowledge of the disease. In most of the cases described, the lesion has shown a predilection for the terminal portion of the ileum, but any part of the intestinal tract may be involved; there have been very few examples of isolated involvement of the colon. According to Crohn,[5] when the large intestine is involved the small gut is also affected. He describes cases in which multiple areas of the small and large intestine have been involved.

The clinical features of the case presented are typical of the findings wherever the lesion appears. Young adults are most commonly affected—males more than females—and the common symptoms are abdominal pains, loss of weight, low-grade fever, anæmia, diarrhœa, with a palpable mass in the abdomen.

According to Crohn, there are four clinical groups :—

1. Those with signs and symptoms of chronic intestinal obstruction.
2. Those with a short history of acute symptoms simulating acute appendicitis.
3. Cases resembling ulcerative colitis.
4. Cases with abscess formation and external or internal fistulæ. These may follow a previous appendicectomy.

The symptomatology of the various groups has been fully described by Crohn and others, and it is not proposed to discuss them here. The case presented falls into the first group.

The radiological findings with a barium enema were similar to those described by Kantor[6] as characteristic of the lesion—a thin slightly irregular linear shadow like a string extending along the length of the filling defect. This appearance is due to the greatly contracted lumen, and has been called by Kantor the " string sign ".

Nothing is known regarding the aetiology of the disease. Although probably of infective origin no specific organism has been recovered from the fæces, the affected intestinal wall, or the lymph-glands. Pathologically, the changes are those of a non-specific granulomatous inflammation associated with ulceration of the mucosa and hyperplastic and exudative changes involving all the layers of the gut. As the condition progresses, the exudative reaction is followed by fibroblastic transformation, with narrowing of the intestinal lumen. The presence of giant cells in histological sections has no doubt been responsible for a frequent diagnosis of hyperplastic tuberculosis, especially when the ileocæcal region has been involved, but careful microscopic examination does not show the characteristics of tuberculosis.

According to Crohn, giant cells are not an essential feature of the pathological process. He attributes their presence to a foreign body reaction around particles of vegetable matter which have entered the lymphatics from the ulcers in the mucosa and become encapsulated in the process of healing. The clinical picture and the gross appearance of the affected gut may resemble tuberculosis closely —but in most of the reported cases there has been no other clinical evidence. The complete absence of any healed or active tuberculosis elsewhere, together with negative tuberculosis tests, is strongly against the lesion being tuberculous. In five cases guinea-pig, rabbit, and chicken inoculations with triturated material from mesenteric glands and from the intestinal wall proved negative for tuberculosis (Crohn).

Chronic regional colitis or enteritis is not likely to be confused with any other condition. It may in some respects simulate ulcerative colitis, but the diarrhœa seldom approaches in severity that of this disease. In ulcerative colitis there is seldom a marked connective-tissue reaction in the wall of the gut, and a tumour mass is seldom palpable in uncomplicated cases. Moreover, sigmoidoscopy usually gives characteristic findings.

TREATMENT

When obstructive symptoms are present the treatment is clear. If the general condition is satisfactory resection of the involved segment of gut is indicated. Resection wide of the affected area is advisable to prevent recurrence at the site of anastomosis. Extension to other parts after resection has been observed. Moschowitz and Wilensky[2] have reported a case in which part of the ileum had to be resected two years after resection of the cæcum. When the general condition of the patient prohibits more radical measures, a short-circuiting operation should be performed, with removal of the involved segment at a later date if symptoms persist.

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ACUTE REGIONAL ILEITIS

A REPORT OF TWO CASES, WITH BACTERIOLOGICAL FINDINGS

By ROBERT MAILER

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In 1932, Crohn[2] and his associates in America described an inflammatory lesion of the terminal ileum which they believed to be a clinical and pathological entity, and for which they suggested the term "regional ileitis". In the original fourteen cases, the disease was limited to the terminal ileum, but subsequent reports in the literature indicated that the same inflammatory process might also involve the jejunum and proximal colon, and that the term 'ileitis' was not sufficiently comprehensive. Nevertheless, the disease in its most typical form is confined strictly to the lower ileum, and for that reason is readily differentiated from ileocæcal granulomata of appendiceal or tuberculous origin.

While the bulk of the literature on the subject is American, a number of cases have been reported in this country, notably by Jackman,[6] Dickson Wright,[9] Edwards,[3] Barbour and Stokes,[1] and Hodgson.[5] On the Continent, recognition of the condition seems to be more tardy, though cases have been recorded from Holland and Scandinavia.

Crohn described four clinical types or stages of the disease :—

1. An acute form with peritoneal irritation resembling appendicitis.
2. A type with symptoms of ulcerative enteritis.
3. A fibro-stenotic type with symptoms of chronic obstruction of the small bowel.
4. A type with persistent and intractable fistulæ in the right lower quadrant of the abdomen following drainage for ulcer or abdominal abscess.

PATHOLOGICAL FEATURES

There is a non-specific inflammation involving all the coats of the small intestine. In cases seen at an early stage or during an acute exacerbation, exudative changes are prominent, especially in the submucous coat, and ulceration of the mucosa is secondary. At a later stage, connective-tissue proliferation converts the intestine into a firm, thickened, rigid tube, with narrowing of the lumen so that obstructive symptoms develop, and a mass may be palpable in the right lower quadrant of the abdomen or on rectal examination.

This corresponds to Crohn's third clinical type, the most common form of the disease, and that which has been studied most extensively from the pathological standpoint. Abundant pathological material has been available, because the disease at this stage frequently demands excision of the affected segment of bowel.

With extension of the disease into the mesentery of the small intestine, abscess formation may arise, with subsequent fistula formation into sigmoid or cæcum, or if the abscess is opened surgically, a persistent external fistula may develop.

The Acute Phase of the Disease.—There have been fewer pathological studies of the disease in its early stage, because spontaneous resolution is possible,

and with the exception of Jackman's cases and those reported more recently by Kate,[7] excision of the affected loop of bowel has not been carried out.

Crohn mentions " one or two cases " in which the patients came to operation after a short illness of a week or two. The terminal ileum was thickened, soggy, and œdematous, and the serous coat a blotchy red colour. The mesentery was also thickened and contained numerous hyperplastic lymph-glands.

The only microscopic studies of the acute phase of the disease are those of Jackman[6] and of Erb and Farmer.[4] In Jackman's cases the mucosa over a wide area was replaced by a thick fibrino-purulent exudate. The mucosa was more severely ulcerated along the mesenteric side of the bowel. In the bowel wall itself, there was an acute inflammatory reaction lessening in degree towards the peritoneal layer, which showed only congestion, œdema, and a few polymorphonuclear leucocytes. This was in marked contrast to the submucous and muscular layers, where in places the degree of polymorphonuclear infiltration approached abscess formation.

Even in Jackman's cases, however, it is obvious that though the lesion in the terminal ileum was operated upon during an acute exacerbation, it must have been present in a latent and asymptomatic form for a very considerable period, as there was marked thickening of the wall of the bowel from fibrous tissue formation.

AETIOLOGY

While it is agreed that the disease is of infectious origin, no specific organism has been identified. There is no evidence that any of the granulomatous infections are responsible, and though giant cells have been recognized in some of the microscopic sections, these have been of foreign-body type and probably related to unabsorbable vegetable particles trapped in the ulcerated mucosa and carried into the deeper layers.

Jackman mentions the finding of streptococci of the intestinal tract group in the floor of the ulcers, while Erb and Farmer isolated *B. coli* from the gall-bladder and mesenteric glands of a child in a case that came to post-mortem examination, but they were not inclined to attach any pathogenic significance to their findings.

It would seem reasonable to suppose that only bacteriological observations made during the acute phase of the disease would be likely to throw any light on the cause of the condition, and it is for this reason that the following two cases are recorded.

CASE REPORTS

Case 1.—J. W., male, aged 29, was admitted to the Victoria Infirmary, Glasgow, on Sept. 17, 1936, as a case of renal colic.

HISTORY.—Three weeks before admission he felt weak and tired, and lost appetite for food. A week later, colicky pains developed in the abdomen and lasted off and on for a day. The bowels were constipated. Three days before admission the colicky pains recurred in more severe form, and on the following day were accompanied by vomiting. Pain and vomiting persisted up to the time of admission to hospital. The bowels acted on the day previous to admission and were reported to be very dark in colour.

ON ADMISSION.—The pain was most prominent on the right side of the abdomen and once or twice radiated to the right groin. No urine had been passed during the previous twenty-four hours.

ON EXAMINATION.—The abdomen was not distended, and moved freely on respiration. The point of maximal pain and tenderness was 1 in. to the right of the umbilicus. There was well-marked rigidity of the right rectus muscle. The temperature was 98·6°, the pulse 68, and respirations 22. The urine (removed by catheter) had a specific gravity of 1022, was acid in reaction, and showed a phosphatic deposit but no abnormal constituents.

The patient was treated conservatively and morphia was administered for the pain.

SUBSEQUENT HISTORY.—

Sept. 19: Patient required catheterization. Twenty ounces removed. No abnormal constituents. Pain and sickness were still present. There was slight melæna.

Sept. 22: There was an attack of looseness of the bowels, with five motions in which blood was present.

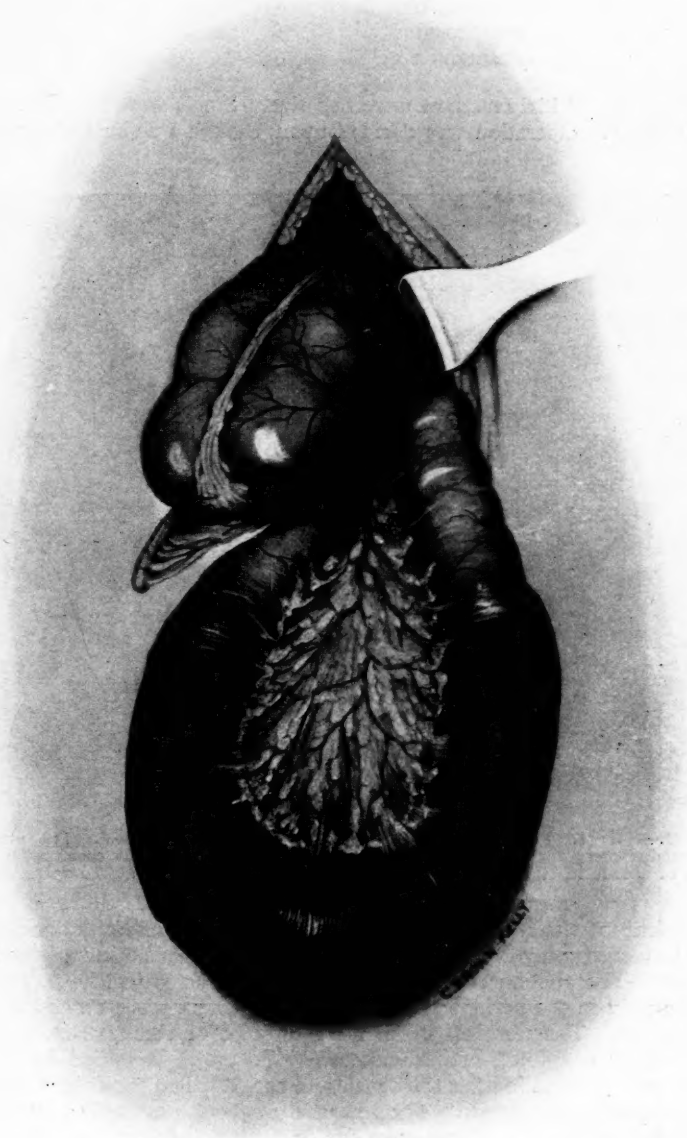

FIG. 370.—*Case* 1. Acute regional ileitis. Note the short segment of normal bowel between the inflamed portion of the ileum and the cæcum, and the enlarged glands in the mesentery.

Sept. 24: After a severe attack of pain to the right of the umbilicus and in the right iliac fossa, the stools were dark in colour and contained fresh blood. The temperature rose to 99·4°, and the pulse to 100.

Blood examination:—	
Red cells	4,660,000
Hæmoglobin	75 per cent
Colour index	0·8
Leucocytes	18,000
Polymorphonuclears	55 per cent
Lymphocytes	30 per cent
Eosinophils	0·7 per cent

Wassermann and Widal reactions were negative. Stools were negative for organisms of the dysentery group. Operation was decided upon, though a definite diagnosis could not be

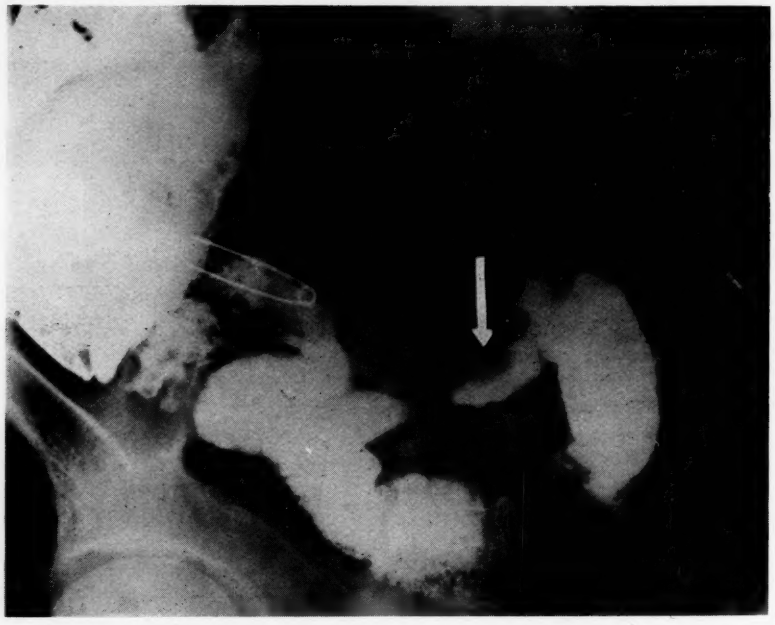

FIG. 371.—*Case* 1. Radiograph taken three hours after barium meal. The proximal portion of the inflamed segment of ileum is shown by the arrow. The distal portion could not be demonstrated on account of spastic irritability. The photograph was taken one month after operation.

established. None of the more usual conditions such as appendicitis, perforating duodenal ulcer, or an intussuscepting Meckel's diverticulum fitted the clinical picture.

OPERATION.—The abdomen was opened by a right rectus incision. There was a small amount of free fluid in the peritoneal cavity. The appendix was pale and atrophic and definitely not inflamed. The terminal ileum for a distance of about 18 in. from the ileocæcal valve was intensely congested and œdematous (*Fig.* 370). It varied in colour from dark red to purple, and on handling felt thickened and soggy. The mesentery was congested and contained large soft fleshy glands. The inflamed segment was fairly sharply demarcated at each end from normal bowel. There were one or two small flakes of lymph on the peritoneal surface of the involved bowel but there was no evidence of peritonitis elsewhere.

The appendix was not removed. The abdomen was closed.

SUBSEQUENT PROGRESS.—The patient's condition began to improve after 48 hours. The bowels opened naturally on the fourth day. On the fifth post-operative day hæmorrhagic petechiæ developed on the left buttock and on the dorsum of both feet at the bases of the toes.

In addition, the dorsum of the left foot showed œdema and pitting on pressure. The frequent association of hæmorrhagic petechiæ in the region of the fingers and toes with the presence of *Str. viridans* suggested a blood-culture. *Str. viridans* was isolated in pure culture.

On the tenth day post-operatively, a herpetic eruption developed along the course of the left supra-orbital nerve. The vesicles rapidly became pustular, and the forehead and scalp round the course of the nerve took on the characters of a low-grade cellulitis. The *Str. viridans* could not, however, be isolated from the fluid in the vesicles.

The patient continued to make a good recovery and was discharged from hospital at the end of six weeks. Before dismissal, barium X-ray examination was carried out (*Fig.* 371). It was impossible to visualize the whole of the affected segment of ileum on account of the spastic irritability still present, but the contraction of the lumen of the proximal portion was well shown. This appearance was still present, though not so marked, in an X-ray film taken six weeks later. The patient, however, has remained completely free from symptoms up to the present (July, 1937).

Case 2.—A. M., schoolboy, aged 14, was admitted to the Victoria Infirmary, Glasgow, on Jan. 5, 1937, as an urgent case of appendicitis.

HISTORY.—Two weeks before admission he developed an "influenzal cold", with headache, sore throat, and, during the first day, abdominal pain. Ten days later, just as the cold and sore throat were disappearing, he developed pain across the lower abdomen and towards the right side. There was nausea, but no vomiting. This pain remained almost constant up to the time of his admission to hospital three days later.

ON ADMISSION.—The tongue was furred and the breath heavy. There was well-marked tenderness in the right iliac fossa with some muscular rigidity. Temperature was 98°, pulse 90, and respirations 20. Urine showed sp. gr. 1018, was acid in reaction, and revealed no abnormal constituents.

A diagnosis of appendicitis was made and operation advised.

OPERATION (Mr. I. M. Burdon).—The abdomen was opened through a gridiron incision. There was copious free fluid in the abdominal cavity. The last 12 in. of ileum up to the ileo-cæcal valve were acutely inflamed and œdematous, and there were large soft inflammatory glands in the mesentery. The appendix showed a mucocele but was not acutely inflamed. It was removed and the abdominal wound closed.

The patient made an uninterrupted recovery. Swabs from the throat yielded *Str. viridans* in almost pure culture, but no organism could be cultured from the blood-stream. He was discharged from hospital on Jan. 30, and has since remained free from symptoms.

COMMENTARY

The close clinical resemblance between acute ileitis and appendicitis has been repeatedly stressed, but in *Case* 1 there were several atypical features which became obvious during the week of observation previous to laparotomy.

It was noted that the pain was of colicky character with periods of remission, and though pain and tenderness were present just to the right of the umbilicus, there was no actual tenderness over McBurney's point. Blood was present in the motions, and for a day there was looseness of the bowels. The employment of the right rectus incision instead of the usual gridiron was further evidence of the diagnostic uncertainty.

These points bear out the contention of Meyer and Rosi[8] that in the presence of symptoms of acute incomplete intestinal obstruction with the physical signs of acute appendicitis, regional ileitis should be considered.

In *Case* 2 obstructive symptoms were not present, and a diagnosis of acute appendicitis was made quite confidently. In point of fact the appendix was actually involved in the general congestion. The localization of pain in the right side from the outset, and, as in *Case* 1, the absence of elevation of temperature and increased pulse-rate, were perhaps not typical of acute appendicitis in young subjects.

Some evidence is also brought forward that a streptococcus of the viridans group may be the infective agent. The isolation of this pathogenic organism from the blood-stream in *Case* 1 was certainly suggestive, and though the handling of the bowel at operation may have been responsible for its appearance in the circulation, the finding is no less valid on that account. It is also well recognized that *Str. viridans* is capable of giving rise to relatively low-grade inflammation similar to that present in regional ileitis.

Unfortunately the finding of this organism does not solve all the problems connected with the causation of the disease. If acute ileitis resembled most other acute inflammatory conditions in going on to complete resolution, it might be justifiable to regard it as septicæmic in origin, and its localization in the ileum as being determined by the large amount of lymphoid tissue there. It may be that there are cases of this type, and *Case* 2 is certainly suggestive in this respect. Again, the cases of acute ileo-colitis in young children described by Erb and Farmer were undoubtedly septicæmic in origin.

On the other hand, it is probable that the disease usually runs a more chronic course, that an acute flare-up is incidental, and is due either to increased virulence of the organisms concerned or to localized venous thrombosis with some degree of hæmorrhagic infarction. The great increase in the amount of fibrous tissue in the wall of the bowel which was a feature of Jackman's acute cases would bear this out.

The disease therefore has some features in common with chronic ulcerative colitis, and has been regarded by some as simply a localized form of this disease. Such a conception does not necessarily minimize the role of *Str. viridans* as the main bacterial invader, but on the other hand, as in ulcerative colitis, it does postulate some additional factor to account for the susceptibility to the disease and its tendency to chronicity.

There is general agreement that acute ileitis should be treated conservatively, as there is a tendency to spontaneous resolution. Laparotomy is, however, always necessary for diagnostic purposes and to determine the actual condition of the bowel and mesentery. If the disease has extended beyond the bowel wall and has caused marked infiltration of the mesentery, spontaneous recovery is less likely, and either short-circuiting or excision may be necessary.

It is unfortunate that there is no account of a follow-up of a series of acute cases, verified at operation but treated conservatively. Many of them get well, but whether they remain well indefinitely, or pass by gradual stages into the chronic fibro-stenotic form described by Crohn, is not known.

From the fact that we have encountered two cases in the Victoria Infirmary within the last year, it would appear that acute regional ileitis is not very uncommon. It is hoped that a wider recognition in this country of the acute phase of the disease will settle the problem of the ultimate prognosis, and will confirm or otherwise the essential role of *Str. viridans* in the aetiology of the condition.

SUMMARY

1. Two cases of acute regional ileitis are described.

2. In one case the symptoms were those of acute appendicitis, but in the other there was the additional feature of melæna.

3. The treatment is conservative, though laparotomy will usually be required to verify the diagnosis.

4. Some evidence is brought forward to indicate that *Str. viridans* is the bacterial agent involved.

My thanks are due to Dr. J. A. M. Cameron for his help in the bacteriological work, and to Mr. I. M. Burdon for permission to report the second case, which was under his care.

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ON CHRONIC INFLAMMATORY 'TUMOURS' OF THE GASTRO-INTESTINAL TRACT

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Of recent years it has been recognized that the so-called specific inflammations (tuberculosis, syphilis, actinomycosis) and the lesions of diverticulitis and ulcerative colitis do not comprise the sum-total of chronic inflammations of the gastro-intestinal tract.

Histological investigation has supplemented this heterogeneous group by the addition of a clinical entity of diverse aetiology, which is characterized by the occurrence of an inflammatory tumour-like mass in some segment of this tract.

Attention was first drawn to it by the early case-reports of the British surgeons Moynihan,[1] Mayo Robson,[2] and Dalziel[3]; and the impetus to further study was derived from the contribution of Braun[4] to the centenary number of the *Zeitschrift für Chirurgie*—"Uber entzündliche Geschwülste am Darm". From that date an increasing literature and numerous reported cases testify alike to the actuality of these inflammatory masses and their far from rare incidence.

Nomenclature.—A variety of descriptive terms has been applied to these tumours, according to their site of origin in the stomach or intestine. Whereas the terms "granuloma" or "chronic inflammatory tumour" (Kirschner and Nordmann[8]) have found ready acceptance among writers for a mass in the stomach or colon, a confusing terminology has been attached to similar tumefactions occurring in the small intestine.

In 1932, Crohn, Ginzburg, and Oppenheimer,[5] under the title, "Regional Ileitis", described "a disease of the terminal ileum affecting mainly young adults, characterized by a subacute or chronic necrotizing and cicatrizing inflammation"—later to become known as Crohn's disease.

From that time a sequence of case-reports by many writers has appeared with a multiplicity of titles, e.g., "localized hypertrophic enteritis" (Jackman[6]), "chronic hyperplastic enteritis", "chronic cicatrizing enteritis" (Barbour and Stokes[19]), and so forth. It is interesting to recall in this connexion that an identical lesion, to judge by the standards of clinical and histological evidence, was described by Dalziel[3] in 1913 with the title "chronic interstitial enteritis".

This variety of nomenclature and attempted differentiation according to the site of the mass tend to obscure the fact that the lesion is one and the same, viz., a chronic inflammatory process, wherever it occurs.

CASE REPORTS

Case 1.—**Chronic inflammatory mass, ileocæcal region. Resection.**

History.—G. H. C., aged 50, licensed victualler. Early in 1935 the patient began to experience pain localized in the right iliac fossa and unaccompanied by vomiting; the pain was intermittent and spasmodic in type. It disappeared after a fortnight, and there was a complete absence of symptoms for a year, when the pain returned in a more severe and persistent form. This time a surgeon was consulted, and he removed the appendix in May,

1936, noting during the operation that the cæcum, though mobile, was "thickened and not normal in appearance". The post-operative course was unsatisfactory. There followed progressive loss of weight, and three months after appendicectomy the pain in the right iliac fossa recurred with pyrexia, general malaise, flatulence, and borborygmi. The patient described this spasm of pain as increasing in severity until a sudden gurgling over the painful area brought him instant relief. During these attacks his bowels had been fairly regular, the motions of normal consistence, and without the passage of mucus, blood, or pus in the stools; nor at any time did he experience diarrhœa.

ON EXAMINATION.—The patient was a man of spare build who had recently lost flesh. The temperature was 100° F., and the pulse 92. Abdominal palpation revealed a tender fixed mass occupying roughly the middle third of the area between the umbilicus and the anterior superior iliac spine. Under the palpating hand the swelling could be felt to become alternately tense and relaxed. There was some loss of resonance on percussion, and on auscultation loud intestinal sounds were to be heard. Palpation per rectum revealed tenderness in the right side of the pelvis. The Wassermann reaction was negative, and a blood-count showed a blood-picture within normal limits.

RADIOGRAPHIC EXAMINATION AFTER BARIUM ENEMA.—"The enema flowed freely to the junction of the cæcum and ascending colon. At this site there seems to be a very definite and irregular filling defect with narrowing of the lumen of the gut".

FIG. 372.—*Case* 2. Radiograph after barium enema.

OPERATION (Nov. 11, 1936).—Exploratory laparotomy under spinal anæsthesia. There was a large fixed mass involving the cæcum and terminal ileum, both of which were markedly thickened. Enlarged but soft lymph-glands were present in the ileocæcal angle. Diffuse adhesions, e.g., of transverse to ascending colon. Ileocolic resection was performed, on the assumption that the mass was malignant, with end-to-side anastomosis of the ileum to the transverse colon.

PROGRESS.—The patient made a good recovery, and his present health is excellent.

HISTOLOGICAL EXAMINATION OF THE RESECTED MASS.—"The microscopical appearances are those of a chronic inflammatory lesion essentially made up of old granulation tissue which contains doubly refractile material, viz., foreign bodies (food particles). There is also present a spheroidal structure, (?) parasitic. Round-cell infiltration is abundant in parts. Sections of the lymph-glands have a normal appearance. The appearances support perforation as having been the cause. There is no evidence of malignancy."

Case 2.—**Chronic inflammatory mass, pelvi-rectal flexure.**

HISTORY.—Mrs. L. E., aged, 64, and mother of eight children, had suffered for some years from vaginal prolapse, for which she had worn a ring pessary. Because of slight vaginal hæmorrhage this was removed by her doctor, who noted some enlargement of the uterus. In August, 1934, subtotal hysterectomy with excision of the left appendages was performed. It is reported that the operation was attended by free hæmorrhage from the cervical stump, and that no pelvic mass was then present. This was discovered by vaginal examination a year later, and was the reason for her admission to hospital.

ON EXAMINATION.—The patient was a stout woman of florid complexion and healthy appearance. Bimanual examination revealed an easily palpable fixed mass in the left lateral quadrant of the pelvis. The Wassermann reaction was negative and the blood-picture within normal limits.

RADIOGRAPHIC EXAMINATION AFTER BARIUM ENEMA.—"The enema flowed with perfect freedom to the cæcum. At the pelvi-rectal flexure there was some irregularity of filling, but no sign of obstruction. The appearances do not suggest an intrinsic lesion of the gut, but rather some pressure from without. There was no sign of diverticula, nor of malignancy. The whole examination was suggestive of an inflammatory mass or simple tumour enfolding or lying up against the rectosigmoid colon." (*Fig.* 372.)

OPERATION (March 9, 1936).—Exploratory laparotomy. Separation of dense adhesions on left side and floor of pelvis. A hard nodular mass, the size of a tomato, at termination of pelvic colon. Marked fixation of mass and extensive infiltration and induration of the meso-colon. Hypertrophy of the pelvic colon. The stump of the cervix uteri was apparently buried in the mass and could not be defined. The whole mass was clearly irremovable, and the abdomen was closed.

PROGRESS.—This patient was seen again in September, 1937. In the interval she had noticed occasional slight hæmorrhage from the vagina, but the mass in the pelvis was no longer palpable on examination.

PATHOLOGY AND AETIOLOGY

Following on Braun's[4] review of the subject, numerous papers have appeared.[7-17] German writers, in particular, have described in great detail the histological appearances. Thus Henke and Lubarsch[7] in their handbook emphasize the frequency of a lesion of the mucosa, e.g., a crack, fissure, or superficial ulcer, as the portal of entry of an infection, slow and of low virulence, leading to the development

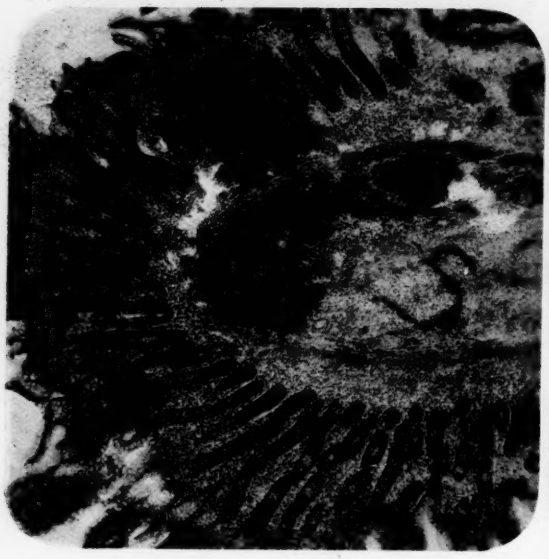

FIG. 373.—*Case* 1. Section showing inflammatory infiltration of submucosa. (× 30.)

FIG. 374.—*Case* 1. Higher power view of *Fig.* 373, showing the edge of an inflammatory mass of lymphocytes and several giant cells of the foreign-body type. (× 150.)

of an inflammatory mass. Through some breach of the mucosa the submucosa is involved, and becomes the seat of a marked inflammatory reaction with small round-celled infiltration (*Figs.* 373, 374). This is not to say that the tissue changes are confined to the submucous coat. A zone of granulation tissue, in its older parts showing cicatricial changes, permeates the musculature (*Figs.* 375, 376). Mural infiltration may be complete, and an infiltrated and thickened serosa contract

adhesions to the parietes, adjacent organs, neighbouring loops of gut, or the retroperitoneum. There may, too, be an invasion of the mesocolon via the lymphatics, which results in its incorporation in the mass, and of which it may form a considerable bulk.

Thus an inflammatory mass develops of some size, and rarely of uniform texture; for in its midst small abscesses and areas of new granulation tissue are to be found as evidence of a recent infection, side by side with zones of older granulation tissue, in which cicatrization has produced a varying degree of shrinking and stenosis.

As to site, the ileocæcal region and pelvic colon are most frequently involved, less commonly the transverse colon, its flexures, and the stomach. Of the last I have seen two examples, associated with chronic perforation of an ulcer and perigastric abscess. In the one, perforation of a pre-pyloric ulcer occurred into the anterior abdominal wall, and a belated operation, performed after the development

FIG. 375.—*Case* 1. Inflammatory infiltration of the muscular coat of the intestine. A multinucleated giant cell is seen in the centre of the field. (× 150.)

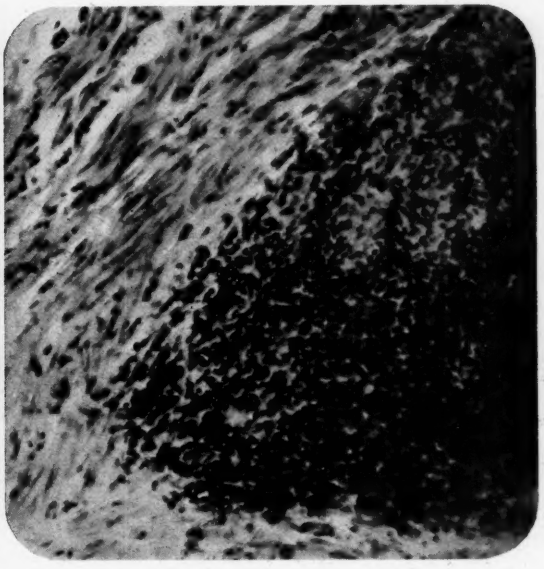

FIG. 376.—*Case* 1. Inflammatory mass mainly composed of lymphocytes in the muscle wall of the intestine. (× 150.)

of a wide area of board-like induration in the parietes, revealed an abscess cavity communicating with the viscus, and surrounded by an inflammatory mass several inches in thickness. Evacuation of pus and drainage by a tube without attempt at closure of the gastric defect resulted in resolution and complete recovery. In the other, an ulcer at the greater curvature had perforated, with the formation of an abscess walled off by the transverse colon, which was extensively infiltrated and incorporated in a huge mass of leathery consistence.

In either case an abscess formed the focal point of an extensive area of granulation tissue, showing at some points massive fibrosis, and both were characteristic of granuloma of the stomach in that this lesion is usually associated with a chronic perforating ulcer. No such single cause, on the other hand, can be assigned to the similar lesion of the intestine. The causes of such are diverse, yet there is a

consensus of opinion that the role played by foreign bodies, e.g., fish-bones, unabsorbable suture material, food residues, is an important one. Many cases have been recorded of granulomatous masses of the large intestine from which a foreign body, e.g., a fish-bone or pin, has been recovered; nor is the absence of such on naked-eye examination conclusive evidence that it can be excluded as a causal factor.

The fate of a foreign body gaining access to the intestinal wall through a breach of the mucosa is variable. Rarely we know it may penetrate the gut wall and, escaping into the peritoneal cavity, occasion a virulent peritonitis. More often it will become immured in the wall, and, resisting solution by the tissues, exert a permanent stimulus. From this chronic irritation a subacute inflammatory reaction occurs, with tracts of granulation tissue, the development of scattered abscesses in the indurated connective tissue, and sometimes fistula formation. On the other hand, it is conceivable that some foreign bodies by reason of their minute size or chemical composition eventually undergo solution by the tissues which temporarily harbour them. To say, then, without the most searching examination of a resected specimen, that no foreign body was present, would seem to beg the question of aetiology. A striking feature of many sections is the presence of giant cells of the foreign-body type (*see Fig.* 374). These have been ascribed to the entrance of small particles of food residue through a mucosal defect exciting a foreign-body reaction.

Concerning other aetiological factors, Kirschner and Nordmann[8] quote the view of Läwen that " the majority of chronic inflammatory tumours of the cæcum arise from a chronic fibroplastic inflammation of the appendix ". In support of it is their personal observation of " a chronic appendicitis of slow development which had transformed the whole cæcum into a tumour of wooden consistence fused to the retroperitoneal tissues by a cartilaginous-like induration ". Removal of the appendix was accomplished with difficulty and gave rise to a fæcal fistula which closed spontaneously. Two years later the repair of a post-operative hernia revealed a mobile cæcum of normal appearance. By contrast, in *Case* 1 recorded above the development of the cæcal mass was not arrested by removal of the appendix five months before the ileocolic resection. Finally, the same authors refer to involvement and infiltration of the colon by direct extension of an inflammatory process from organs in its vicinity, e.g., the sigmoid flexure by adnexal disease. Füth [11] described a case of this type—" a hard mass the size of a fist in the pelvis comprised of a board-like infiltration of the sigmoid flexure and its appendices epiploicae, and adherent to an inflamed left appendage, the whole being suggestive of carcinoma ". *Case* 2 conforms closely to this type of invasion of the colon.

DIAGNOSIS

A differential diagnosis from malignant disease or the specific inflammations causing intestinal ' tumour ' is hardly possible before exploration, and actually is rarely made at operation. Usually histological examination of the resected mass furnishes the first clear evidence of its nature.

TREATMENT

Resection of the tumour-like mass is the ideal course, but in many cases must be impracticable from the presence of dense adhesions to the retroperitoneal tissues

or adjacent organs. Under these circumstances, short-circuiting anastomoses have been employed with success, as in the case recently reported by Hodgson.[18]

From time to time cases of spontaneous disappearance of the mass have been recorded after simple exploration.

SUMMARY

Two cases are recorded of chronic inflammatory 'tumour' of the colon.

The inflammatory mass is the response of the tissues to a slow infection of low virulence, and may develop at any point in the gastro-intestinal tract.

Wherever it arises, the same chronic inflammatory reaction is responsible.

The path of infection may be via the mucous membrane or from without.

The role of foreign bodies as a causal factor is reviewed.

The writer wishes to express his thanks to Dr. A. W. Laing for the histological report, to Dr. J. Blair Hartley for the radiographs, and to Professor S. L. Baker, of the Department of Pathology, University of Manchester, for the microphotographs and much informal counsel.

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CROHN'S DISEASE, OR REGIONAL ILEITIS

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"A DISEASE of the terminal ileum, affecting young adults, characterized by a subacute or chronic necrotizing and cicatrizing inflammation, ulceration of the mucosa and excessive connective tissue formation through the wall, leading to stenosis and fistula formation". In these words Crohn,[1] in 1932, described a localized disease of the ileum of a granulomatous nature, and gave it the name "regional ileitis".

Since that time it has become evident that other parts of the intestinal tract may become involved in such a process. Harris, Bell, and Brunn,[2] in 1933, recorded the involvement of the jejunum only, and in 1934 Colp[3] described the first example in which large and small bowel were together affected. Many other cases have recently been described, some being earlier examples of obscure intestinal granulomata reviewed in the light of Crohn's researches, and others being recent types conforming to the entity which he described. Thus Koster, Kasman, and Sheinfeld,[4] and J. Sproull,[5] each reviewed in 1936 a large number of recorded cases, the former 126 and the latter 132, including not only the more recent and carefully observed examples, but also the older and less certain forms of granuloma. In these papers it is claimed that Crohn's disease may be found anywhere from the jejunum to the sigmoid colon, involving either long or short segments, and often several sections of intestine separated from each other by normal bowel. The record of T. K. Dalziel[6] is quoted, who, in 1913, gave two instances in which almost the entire small and large bowel were affected. He called it "chronic interstitial enteritis".

It is uncertain that these conform to the granuloma described by Crohn, and it is in our view desirable that only recent authenticated cases be included in this category. Jackson[7], in a recent communication, refers to 219 such instances reported in America since Crohn first gave his classical description in 1932. Jackman[8, 9] in 1934 and 1937, H. Schwabacher[10] in 1936, and Colbeck, Hurst and Lintott in 1939[18], have recorded the incidence of the condition in this country.

It is our view that this is a new disease; we do not believe that a pathological condition of such a definite nature, and so unlike any of the known diseases of the intestine, can have remained for long unrecognized in this keen and critical surgical age. When operating upon the first of the cases which form the basis of this paper, we were hardly aware of Crohn's description, and yet the pathological appearance, disclosed at operation, left us in no doubt that here was something which we had never seen before, something that was not tuberculosis, malignant disease, or ulcerative colitis, and something which for its cure required radical treatment. The picture was very striking and unforgettable; the thick, solid loop of intestine with fat standing out predominantly; even more, the heavy infiltrated mesentery, red and œdematous, with swollen glands massed within its thickened substance.

The original description has been modified, and Crohn[11] himself in his most recent paper acknowledges the not infrequent implication of the cæcum and ascending colon in the disease, as well as segments of the small intestine other than the terminal ileum.

AETIOLOGY

Though the condition was first described as one affecting young adults, it is by no means confined to the earlier decades. Koster[4] in a study of 67 instances found that 43 of these occurred in patients below the age of 40, that 6 were under 10 years, but 5 were over 70 years of age. The first of our cases was aged 52 years, and the second 21 years. Both were females. Koster has found the sexes nearly equally represented, 33 of 62 examples being males and 29 females.

No definite conclusion has been reached as to the causation of regional ileitis. In our two cases, lymphatic œdema stood out primarily, the engorgement of the mesentery and the glands being almost as striking as the turgidity of the intestinal loop. Lymphatic obstruction as an aetiological factor is discussed by Jackson,[7] who remarks upon recent animal experimental work; Reichert and Mathes[12] produced a chronic lymphatic œdema of the intestinal wall, akin to regional ileitis, by the use of sclerosing solutions injected into mesenteric lymphatic vessels. These workers believe that the dominant features of Crohn's disease are a low-grade lymphatic infection with subsequent obstruction.

By microscopic section, culture, and animal inoculation, the tubercle bacillus has been acquitted, and the pathological appearances do not resemble such an infection. Felsen,[13] by the study of blood-serum agglutination, suggests that *B. dysentericus* is the causative factor, but Crohn[11] denies this, recording only one positive finding in a series of examples investigated serologically. Mixter[14] has found various streptococci: others have blamed anatomical abnormalities of the ileum and associated structures, anomalies of position and fixation resulting in stasis. The accidental piercing of the mucosa by a fish-bone or similar body with subsequent bacterial invasion, twisting, kinking, and intussusception have all been put forward in the attempt to find the aetiological basis. This, however, still remains obscure.

CLINICAL AND PATHOLOGICAL FEATURES

In the first and classical description, Crohn's disease was shown to be a progressive state, passing through a series of stages to a fatal termination. In the *early or acute phase*, a peritoneal reaction gives rise to symptoms suggestive of appendicitis, and it is at operation for this that many cases have first been brought to light. A small segment of reddened and thickened bowel is found, often located close to the ileocæcal angle, with a clear peritoneal exudate.

A *second stage*, in which mucosal ulceration predominates, is productive of symptoms of intestinal irritation, with frequent stools, often containing mucus and blood. It is now that colitis is often blamed, though bacteriological examination has proved consistently negative. The mucosal ulcers have been found to be frequently linear, being largely placed along the mesenteric border of the bowel.

In the *third stage*, narrowing of the intestinal lumen produces the clinical features of obstruction of the lower ileum. Cramping and colicky pains around and below the umbilicus, nausea and occasional sickness, with constipation or small

diarrhœic stools, become evident. Visible peristalsis and abdominal tumour are added to the picture, and this then becomes essentially a surgical phase. Abdominal tuberculosis may now be diagnosed, and if operation is performed the fully developed condition of ileitis is revealed.

The *fourth stage*, that of adhesion and fistula, is reached, in the majority of patients, where surgical intervention is withheld. Adhesions are dense, intestines matted, frequently with abscesses between. Fistulous tracts develop in connection with the surface of the abdomen or with neighbouring hollow viscera. A persistent and non-healing fæcal fistula appearing in the healed scar of an appendicectomy may occur where Crohn's disease is the underlying factor. Fistulæ from the diseased loop to the colon and bladder have been described. It is now that actinomycosis may be suspected, though pathological investigation fails to confirm this diagnosis.

The course of the disease may be run in the short period of a few months, or it may last two to three years. It is characterized by a progressive secondary anæmia, by wasting and advancing weakness. The leucocyte count gives little assistance, sometimes being raised to 12,000 or 15,000, but frequently being lowered. There is some evidence that the process may be arrested in the earlier phases and that the bowel may return to normal, provided the disease has not progressed too far.

RADIOLOGICAL FEATURES

The radiological diagnosis of regional ileitis has been most ably set forth by J. L. Kantor,[15] and in many instances a pre-operative diagnosis of the condition may be so confirmed. A barium examination by both meal and enema, carried out with fluoroscopic screen and serial photography, may show definite changes corresponding to the earlier and later phases of the disease. The earlier changes are shown in a loss of segmentation and peristalsis in the lower ileum, and an absence of variation in the diameter of the lumen reveals rigidity of the intestinal wall. A somewhat later stage shows a filling defect of the terminal ileum, often a tapering of the shadow towards the cæcum. Such irregularities may be seen to extend to the large bowel, where at first, before organic change has occurred, a spasm of the cæcum results in an intermittently contracted, teat-like appearance. A fixed and permanent cæcal deformity indicates that the disease has spread beyond the ileocæcal valve, to the wall of the large bowel.

In the third phase, the tubular stricture of the ileum may result in the appearance of a thin line of barium passing from dilated small gut above to the ileocæcal angle below. This, the "string sign" of Kantor, though not pathognomonic of Crohn's disease, may, when taken with other radiological and clinical evidence, make the diagnosis of the condition a certainty. It may, however, be simulated by the outline of an appendix or of a spastic segment of ileum, and syphilis, sarcoma, and tubercle may produce a similar shadow. It is well seen in *Fig* 377, a radiograph taken during an enema examination of our first example.

TREATMENT

Crohn,[1] in his first paper, concluded that palliative treatment was of little value, that a short circuit alone did not arrest the process, and that resection should be done. In his most recent communication, based on an experience of 65 cases,[16] he still believes that removal is best, where this may safely be carried out.

In regional ileitis in the acute or irritative stage, there is evidence that resolution and natural cure without surgical measures may sometimes take place. Thus, Koster[4] records 8 early cases which resolved without surgical procedure. But he also mentions 6 early cases, not operated upon after discovery, which progressed so markedly that surgical measures were necessary at a later date. Resection in the acute phase undoubtedly carries a higher operative risk than that carried out later; thus Crohn[16] records the loss of 2 of 7 patients resected at this time, whereas Koster[4] gives the operative mortality in 100 cases in all stages as 14 per cent. It may thus be deemed desirable, in the present state of our knowledge, to treat conservatively those instances brought to light in the earliest phase, keeping these under continual review.

Ileo-colostomy, short-circuiting the diseased segment of bowel, would appear to have a definite though restricted place in the treatment of Crohn's disease. Pemberton and Brown[17] prefer a two-stage operation, end-to-side ileo-colostomy preceding resection. They regard this as safer than a one-stage removal, since inflammatory reaction or intestinal obstruction is frequently associated with the condition. These writers mention 6 patients who underwent the first stage only, who are well after periods varying from two to five years. Crohn and Koster both record similar instances, but all of them report in addition patients whose disease has progressed, undeterred by the anastomosis above. All have found, too, that the best results have been obtained where the diseased bowel has been extirpated, though the passage of time will reveal the value of these procedures. Koster concludes that in the second stage, that of mucosal ulceration without occlusion of the lumen, the bowel may still be capable of recovery, and believes that a short-circuit may thus occasionally be allowable; resection is carried out later, if under observation the disease is found to progress.

Resection in one stage, if this may be carried out with safety, saves the patient from a double ordeal, and in our cases this was possible, giving rise to no post-operative anxiety. In the later stages, with the advancing lesion, the threatened obstruction, and the spread of the disease beyond the confines of the bowel, it is agreed by all that resection is the correct procedure.

Palliative treatment, as a whole, in all but the early phase, is of little value. Medical treatment is useless, though the intake of a carefully selected non-roughage diet may result in a temporary improvement.

CASE REPORTS

Case 1.—Mrs. R. C., aged 52 years, was admitted to hospital on March 29, 1936, under the care of Mr. Norman White, complaining of colicky pain around the umbilicus and in the right lower quadrant of the abdomen.

She was well until five months before coming to hospital, when she experienced an attack of diarrhœa which lasted from one to two weeks, the stools being frequent and containing blood and slime. This had not recurred. Since that time she noticed the gradual onset of abdominal pain with occasional nausea, and the bowel had become constipated. The appendix had been removed some years before.

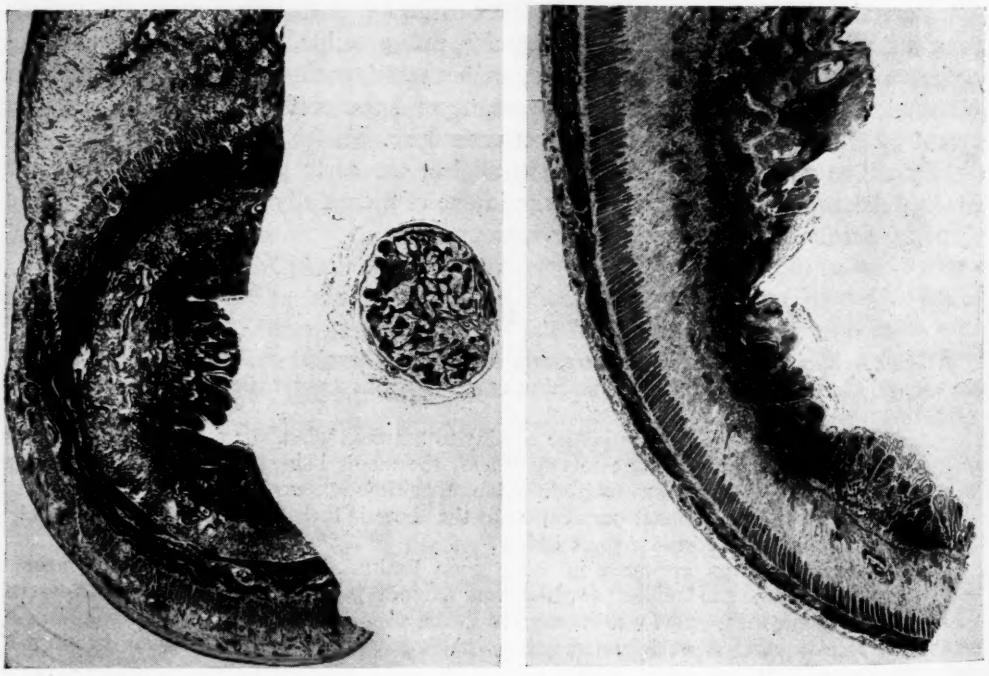
She was adipose and appeared in fairly good health. The abdomen was of normal contour, and a vague and tender swelling was evident in the right iliac region. Rectal examination was negative. She was transferred to the surgical side and an examination under anæsthesia carried out. A well-defined semi-movable mass was found, cylindrical in outline, and unconnected with the pelvic viscera.

An X-ray examination by barium enema showed a well-marked filling defect of the terminal ileum and cæcum. This we now know to be a typical example of Kantor's " string sign ", and in addition the contracted teat-like cæcal deformity is evident (*Fig.* 377).

FIG. 377.—*Case* 1. The " string sign " of Kantor. An X-ray photograph following a barium enema. The terminal ileum shows a typical narrowing, and the cæcum a teat-like contracted appearance.

An exploratory laparotomy was carried out (L. E. B.-W.), using a right lower paramedian approach. The terminal twelve inches of the ileum was solid and œdematous, its peritoneum thickened and pale and encroached upon by fat. The whole segment was of firm and leathery consistency. The corresponding mesentery was reddish, turgid, and contained large fleshy lymphatic glands. Proximally, the condition passed gradually to normal ileum, and distally the disease involved the cæcum and proximal part of the ascending colon. The bowel was divided above the diseased loop, and the terminal ileum, cæcum, and ascending colon were excised, the proximal cut end of the small bowel being implanted into the transverse colon by end-to-side anastomosis. Recovery was uneventful and she has remained well to the present time.

The specimen, now in the Museum of the Royal College of Surgeons, is shown in *Fig.* 379. Histologically, the serous, muscle, submucous, and mucous coats of the bowel are infiltrated by inflammatory cells, and a clear mucoid substance is evident through the whole. Many lymphoid and mononuclear cells are present. There is ulceration of the mucosa in many places.



A B

FIG. 378.—*Case* 2. The thickened wall of the ileum in (A) transverse and (B) longitudinal section. Note the infiltrated mesentery in the former example. (× 4.)

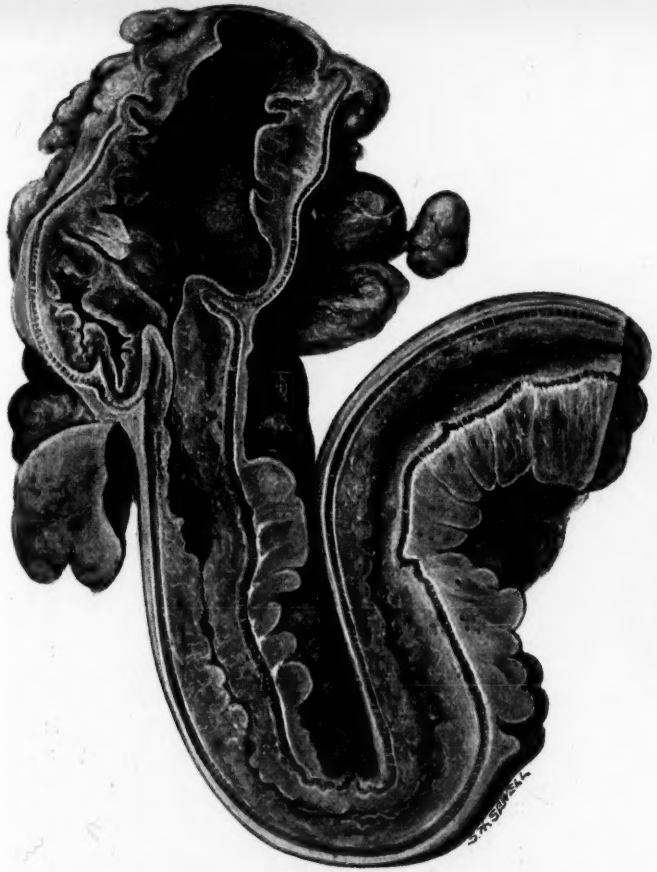


FIG. 379.—*Case* 1. Crohn's disease, involving the terminal ileum, cæcum, and ascending colon. The specimen illustrates the third stage of the condition, that of intestinal occlusion.

FIG. 380.—*Case* 2. Crohn's disease of the ileum. The process is seen to extend into the wall of the proximal dilated bowel, involving the Meckel's diverticulum.

Case 2.—Mrs. B., aged 21 years, was first seen in consultation with Sir John Weir in May, 1937. She had been confined five months before. Since that time she had been suffering from marked flatulence following her meals, loss of appetite, and constant diarrhœa, and had herself noticed a swelling in her abdomen. She had lost two stones in weight.

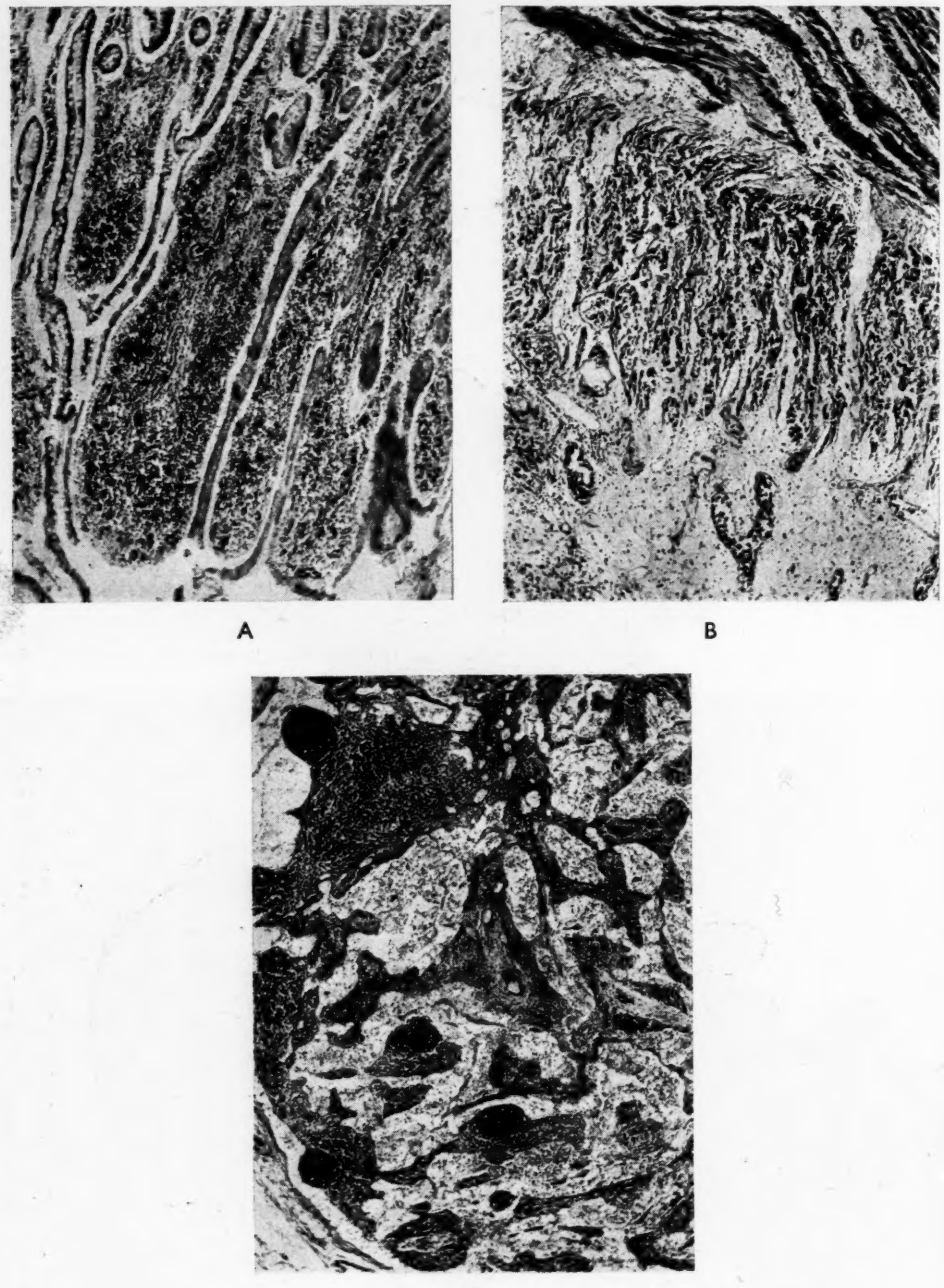


FIG. 381.—*Case* 2. Microphotographs showing (A, B) the inflammatory infiltration of the mucous, submucous, and muscle layers of the bowel and the associated œdema (× 45), and (C) a section of a mesenteric gland (× 20).

On examination she was pale, somewhat wasted, and ill-looking. A swelling was palpable in her abdomen to the right of the umbilicus—cylindrical, tender, and movable. The blood examination showed 17,000 white cells, with 75 per cent polymorphs; no abnormality was found in the fæces (Dr. F. H. Teale). An X-ray examination by barium meal showed no abnormality.

A tentative diagnosis of regional ileitis was made, and confirmed at operation (L. E. B.-W.). The omentum was adherent to the mass by recent adhesion; a coil of ileum, eight inches in length, ending at approximately 2 in. from the ileocæcal valve, showed the typical appearances of Crohn's disease. The proximal intestine was dilated and contained a Meckel's diverticulum, adherent by its tip to the mesentery. As seen in *Fig.* 380, this, too, was involved in the pathological process. The affected part was removed, the cut ends of the ileum were closed, and a lateral anastomosis was performed between the proximal bowel and the cæcum. The patient made a good recovery and was discharged three weeks after operation. Up to date she has remained well, and at six weeks had gained one stone in weight.

The histological appearances found are shown in *Figs.* 378, 381.

SUMMARY

1. Some of the literature relating to Crohn's disease is reviewed.

2. The aetiology, clinical and pathological features, radiological diagnosis, and treatment are discussed.

3. Two cases are reported and illustrated.

We are indebted to Dr. L. W. Proger, of the Royal College of Surgeons, for his kind help with the pathological investigations.

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BRAIN ABSCESS*

By GILBERT HORRAX, Boston

Forty-two years have elapsed since Sir William Macewen[1] wrote as follows in the preface to his classical book upon *Pyogenic and Infective Disease of the Brain and Spinal Cord*: "Ten years ago a physician reported in *The Lancet* a case of an abscess of the brain discovered at post-mortem in one of the London hospitals and quoted the remark of an eminent surgeon who saw it, that an abscess of the brain was one of those cases which occurred but once in the course of a lifetime. An individual experience of the last ten years given in this volume and supported by numerous cases recorded by other surgeons, affords quite a different estimate. . . . Though not sharing the hopelessness of the opinion expressed in 1883 by a distinguished neurologist as to the inutility of operations on the brain undertaken for abscess, the author was then inclined to take a more sombre view of the prospects of recovery from such operations than his subsequent experience has proven to be necessary. *He now regards an uncomplicated cerebral abscess, early recognized, accurately localized and promptly operated on* as one of the most satisfactory of all intracranial lesions, the patient being at once relieved from a perilous condition and usually restored to sound health."

With this statement before us, it is interesting to note the general methods which Macewen employed in the treatment of brain abscesses, and the success with which they were attended. His usual technique was first to gain as much information as possible as to the exact location of the abscess, particularly as to where it most nearly approached the surface of the brain and skull. Next he made a rather large bony opening over the site of the abscess, after which the cavity was opened widely and thoroughly washed with a mild antiseptic solution. Finally he placed within the cavity, in order to give it free drainage, a decalcified chicken bone. A dressing was then applied *and left in place*, usually for several weeks. When the dressing was removed the wound was often completely healed.

Using this technique, Macewen reported the results in a series of 26 abscesses situated within the brain substance. Two of the fatal cases (both cerebellar) were not operated upon by Macewen himself, but were presumably under the care of an assistant trained in his methods. Among the total 26 cases, irrespective of whether they were or were not operated upon, there were 8 deaths, a mortality of 30·7 per cent. If we take only the 24 patients under Macewen's personal care, there were 6 deaths, or a mortality of 25 per cent. Of these, however, only 20 were operated upon, with 2 deaths, giving an operative mortality of 10 per cent.

Since Macewen's day, no one, so far as I can ascertain, has been able to duplicate his highly successful treatment of brain abscesses in a large series of cases. There are, perhaps, many reasons to account for this, but by studying in detail the case reports which he gives, three factors seem to play the most

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* Amplification of a paper given at the joint meeting of the British and American Societies of Neurological Surgery, London, July, 1935.

important roles. In the first place, practically all of Macewen's patients had chronic, encapsulated, single abscesses which had been present, as a rule, from two to three weeks up to a matter of six months or longer.* In the second place, he used every means available at that time to drain the abscess where it most nearly approached the surface. Lastly, he made a fairly large bony opening and held the abscess cavity widely open with his decalcified chicken bone.

Gradually, during the past ten years especially, neurosurgeons and otologists have re-emphasized many of these principles as more concentrated thought has been directed toward the subject. Thus Eagleton[2] has written extensively on the pathways by which infection extends from the otitic process into the brain, and McKenzie[3] has called attention to the importance of opening the abscess at its nearest approach to the surface. Grant[4] demonstrated the great advantage in holding off operation, if possible, until capsulation had taken place, while Cahill[5] and King[6] particularly have stressed repeatedly the favourable results of wide open drainage. For this purpose Cahill and recently Kaplan[7] have advocated the use of the Mosher wire drain, but it is probably the general principle rather than the particular form of drain which is most important. To my mind the method of treatment described by King is ideal in cases to which it is applicable. It is similar in its essential aspects to the technique called " marsupialization " by Cushing and used by him for many years. This technique I described briefly in 1934,[8] and it will be referred to subsequently. In a recent paper Adson and Craig[9] have likewise advocated a somewhat similar method, using two catheters and gauze packing in order to hold the cavity widely open and thus to prevent ' pocketing '. In 1934 Cairns[10] discussed various aspects of the treatment of brain abscesses, showing that no single method could be utilized in all cases. He wisely emphasized the importance not only of applying correctly whatever method seemed indicated, but of giving the patient the advantage of extremely careful after-treatment. In contrast to these methods of opening the abscess widely, occasional successes have been obtained by single or repeated tappings of a brain abscess, as described by Dandy.[11] This procedure undoubtedly has its place in the treatment of deep-seated abscesses or those which contain sterile pus. It is likewise helpful in unencapsulated abscesses as a means of lowering intracranial pressure in the hope that the abscess may become encapsulated, after which it can be dealt with in the more usual way. This, likewise, was a principle taught and used by Dr. Cushing, but in my opinion it should never replace marsupialization or similar open methods in superficial encapsulated abscesses. A third procedure sometimes used for the eradication of a brain abscess is total extirpation. Operations of this type have met with success at times, as in three instances here recorded, but there are obvious drawbacks and dangers to such an undertaking.

Irrespective of the surgical methods employed, however, it must be admitted that the present mortality reports for brain abscesses are discouragingly high, ranging from 22 per cent up to 56 per cent. This very considerable discrepancy can doubtless be explained not only by the types of procedure used for drainage, but more readily perhaps by the fact that in some papers (those with the lower

* This seems to contradict the statement made by Macewen and quoted at the beginning of this article concerning the early recognition of an abscess. However, for those days the early diagnosis of a brain abscess may have meant within several weeks or even months of its onset.

mortality rates) only chronic encapsulated abscesses were dealt with, while in others all varieties, such as metastatic, multiple, and acute abscesses, were included. It is because of this frequent lack of classification that comparisons are not always possible, but even with chronic encapsulated abscesses mortality statistics during the past ten years have been reported as high as 30 to 40 per cent from some of the leading neurosurgical clinics in America and in Europe.

The purpose of this paper is to review a series of 30 cases seen during the years 1926 to 1935,* with special reference to their grouping and remarks concerning the methods of treatment. All of these patients had true intracerebral or intracerebellar abscesses. Any instances of extradural or subdural collections of pus sometimes included in the general term of ' brain abscess ' have been eliminated. In order that a clear idea may be had of the type of brain abscess under discussion, and thus, if profitable, to compare the methods of treatment here advocated with those, for instance, which were alluded to in Macewen's series, we must separate the 30 cases of our own into two entirely distinct groups.

Group I.—ACUTE AND MULTIPLE (OFTEN METASTATIC) ABSCESSES USUALLY HAVING SERIOUS PULMONARY OR SYSTEMIC COMPLICATIONS

The first group may be dismissed briefly, because, in reviewing the case histories, it is extremely doubtful whether any of them should have been regarded as surgical problems and subjected to an intracranial operation, even of a palliative variety. Such procedures as were carried out were for the most part simple tappings, done with the vain hope that if intracranial pressure was relieved the patient might be able to overcome the accompanying serious systemic condition. In no instance was this hope fulfilled.

Of the patients 12 came within this category, and of this number 10 were operated upon. Six patients had metastatic abscesses with complications such as bronchiectasis, lung abscess, empyema, etc. The other 6 had local complications in the form of meningitis or spreading encephalitis or the abscess had already ruptured into the ventricle.

No case in *Group* I survived either with or without operation, and it is my impression that little can ever be expected in the treatment of such seriously complicated conditions, except perhaps in an extremely occasional instance.

CASE REPORTS

One or two brief case histories will suffice to illustrate the conditions obtaining in this group.

Case 1.—B. M. G. (P.B.B.H. Surgical No. 36455), a 12-year-old girl, was referred by Dr. S. S. Martin, of Windsor, Vt., on May 12, 1930.

HISTORY.—She had had an empyema of the right chest drained seven weeks previously. Four weeks later she began having headaches and vomiting, and rapidly developed a left

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*This series comprises cases seen and treated during the period mentioned. A large number of them were operated upon by the author in the Clinic of Harvey Cushing at the Peter Bent Brigham Hospital, and to him the author wishes to make grateful acknowledgment. The other patients were operated upon by the author at the New England Deaconess and the New England Baptist Hospitals, the Children's Hospital, Boston, and the Rhode Island General Hospital.

hemiparesis. Examination showed an emaciated child with bilateral choked disks of 4 diopters, a bilateral abducens palsy, and a left hemiparesis and hemihypæsthesia. Her white blood-count was 22,000, red blood-count 3,200,000, and her hæmoglobin was 60 per cent.

OPERATION.—This was carried out immediately upon the date of her admission. A small burr opening was made in the bone over the right parietal region, a ventricular needle inserted, and 25 to 30 c.c. of thin yellow pus evacuated from an abscess at a depth of 3 cm. below the cortex. The patient was coughing up greenish pus, so her chest was tapped also. Five days later her cerebral abscess was again evacuated by the insertion of a needle, but she died the same day.

POST-MORTEM EXAMINATION.—Necropsy confirmed the clinical findings of a brain abscess with meningitis; bronchiectasis with lung abscess, empyema, and bronchopneumonia. Cultures from the pulmonary processes showed a non-hæmolytic streptococcus.

Comment.—There is little to say about such a case except to repeat that any form of intracranial operation under similar systemic conditions seems almost unwarranted. On the other hand, when confronted with the decision clinically, it is difficult to refuse at least some such simple attempt to save a life.

The following record illustrates the second type of these hopeless cases, although in many of this variety it may not at first be possible to diagnose multiple lesions.

Case 2.—J. R. W. (P.B.B.H. Surgical No. 26599), a 40-year-old white male, was referred by Dr. A. R. Gardner, of Lowell, Mass., on June 16, 1926.

HISTORY.—The patient had had pleurisy followed by empyema in February, 1926, and this was complicated by osteomyelitis of the left femur three weeks before admission. Frontal headache and paralysis of the left arm and leg had developed six days prior to entrance, and he had had one convulsion three days previously. Neurological examination showed early choked disks with $\frac{1}{2}$ D elevation, and the left pupil was larger than the right. He had a left partial hemiplegia, paralysis being complete in the left arm. His deep reflexes were greater on the left than on the right, with a positive Babinski on the left. There was likewise a hemihypæsthesia of the left side.

OPERATIONS.—These consisted in three cerebral tappings, the first of which was carried out on June 22, 1926, over the right parietal region. A small abscess was reached at a depth of 5 cm. below the cortex and 6 c.c. of thick pus evacuated. Pneumococci were disclosed by smear, but cultures were negative. Further taps were made at the same site on June 25 and July 3, the former being negative, the latter yielding 10 c.c. of pus. The patient died on July 8.

POST-MORTEM EXAMINATION.—Necropsy disclosed seven scattered brain abscesses, six of them being in the cerebral hemispheres and one in the cerebellum.

Comment.—It could not be told from this patient's examination that multiple abscesses were present; therefore, the operative procedures seem quite warranted. Certainly no more radical measures than repeated tappings could have been considered with an abscess at so great a depth below the surface.

Group II.—CHRONIC SINGLE ABSCESSES (USUALLY ENCAPSULATED)

The second group is the one with which we are particularly concerned, as it represents the cases which are distinctly amenable to surgical therapy. The types of treatment are to be discussed, not only as to their technical features, but in connection with the clinical application or indication for one method or another, and a brief word as to the aetiology of the abscesses in this second group would appear to be of value.

Into this group fall the remaining 18 patients, and it is abscesses of this type which form the bulk of those in reported series, including that of Macewen. All of our patients in this class were operated upon, and all survivors have been followed from approximately one to six years, the majority from two years upward, so that there is little chance of any having a latent process which might again become active.

Aetiology.—Two possible comments might be made concerning the sources of infection from which the brain abscesses in this group are derived. In the first place, the variety of antecedent infection was doubtless greater than that usually seen by otolaryngologists, although middle-ear complications were the largest single factor. In the second place, osteomyelitis of the skull or frontal sinusitis accompanied by osteomyelitis accounted for one-third of the total number of abscesses.

The following is a list of the aetiological factors :—

Otitis media and mastoiditis	4
Osteomyelitis of skull	3
Frontal sinusitis	3
Dental abscess	2
Scalp abscess	2
Nasal furuncle	1
Tonsillar infection	1
Upper respiratory infection	1
Unknown	1
Total	18

Mortality.—The total operative mortality in *Group* II was 16·6 per cent, as there were 3 deaths among the 18 patients during their stay in the hospital, which averaged about 8 to 10 weeks. Of those who died, two succumbed to meningitis following a spreading osteomyelitis of the skull. In the other the abscess was never found, a cerebral tap reaching the ventricle when the patient was *in extremis*. Thus, there were in reality but 2 deaths in 17 cases in which the abscess was treated, making the mortality 11·7 per cent. One patient died five months after leaving the hospital from a cause unrelated to his abscess.

Five of the fourteen survivors have certain disabilities, as follows : Two have developed convulsions. One of these and two others have weakness of one arm and leg. The fifth patient has visual acuity reduced to reading large print, but gets along very well in school.

METHODS OF TREATMENT

It will be seen from the accompanying table (*Table I*) that, although a number of different procedures are listed, only three of these need be considered seriously—

Table I.—Chronic Encapsulated Brain Abscess : Summary of Methods of Treatment and End-results

Method	No. of Cases	Lived	Died
Marsupialization	9	8	1
Tapping	4	4	0
Extirpation with drainage ..	3	3	0
Drainage only	1	0	1
Cerebral tap (abscess not found) ..	1	0	1
	18	15	3

namely, marsupialization, tapping, and extirpation of the abscess *en bloc*. The case in which no abscess was found by an attempted tap is included only for the sake of completeness, and the patient whose abscess was drained merely by the insertion of a gutta-percha wick had complicating circumstances which prevented any more radical attack upon the lesion.

Marsupialization.—One-half of the patients were treated by this method, with one death—a mortality of 11·1 per cent. Because of the highly satisfactory results by this procedure, it is my strong feeling that whenever one is dealing with a well-encapsulated abscess within 1 to 3 cm. of the surface of the cortex, marsupialization should be the treatment of choice. A brief description of its technical steps may be given.

TECHNIQUE.—An opening (roughly circular) about 3·5 × 3·5 cm. in two diameters is made in the skull as nearly as possible directly over the area where the abscess is closest to the surface. This may be determined in some instances by one or more small burr holes over the suspected area and then gently inserting a blunt ventricular needle until abscess wall is felt, as described by McKenzie (*Fig.* 382). In other instances the site of the abscess may be shown with exactness

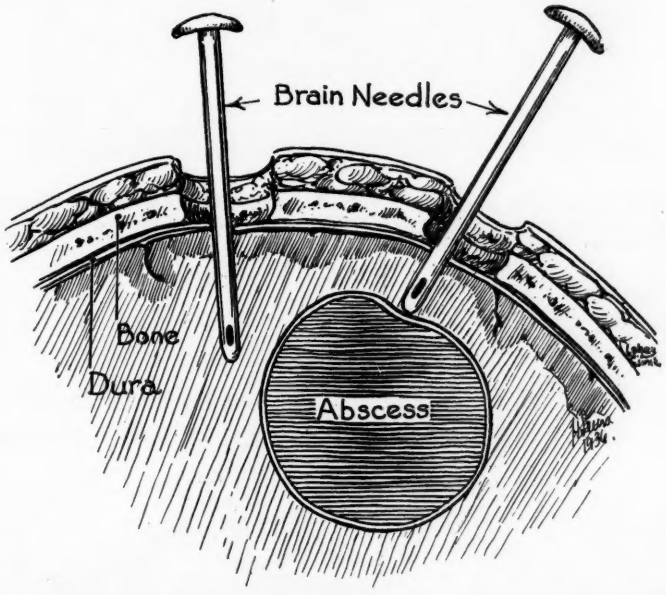

FIG. 382.—Localization of a brain abscess by means of tapping over the suspected area. (*After McKenzie.*) Drainage would be instituted where it was shown that the abscess came nearest the surface.

by ventriculography (*Fig.* 383). The dura is next opened by radiating incisions to the limits of the bony opening. Cortex, as a rule, will bulge markedly through this opening, and should be removed quickly down to the abscess capsule by electro-surgical methods (*Fig.* 384). Capsule will now tend to bulge upward into the uncapped area and will often approach the surface, even though it may at first have been considerably below the cortex.

The next manœuvre is to empty the abscess partially so that tension may be reduced and consequently, when capsule is later opened widely, there will be no

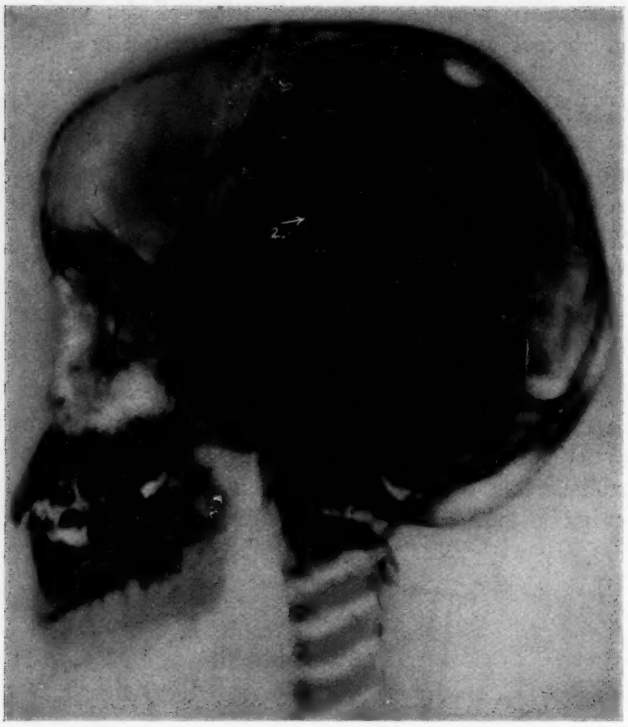

FIG. 383.—Localization of a brain abscess by ventriculography. Arrow 2 points to the blunted and pushed-back anterior horn of the left ventricle due to a left frontal lobe abscess. Arrow 1 indicates normal right ventricle. (*Surgical Clinics of North America.*)

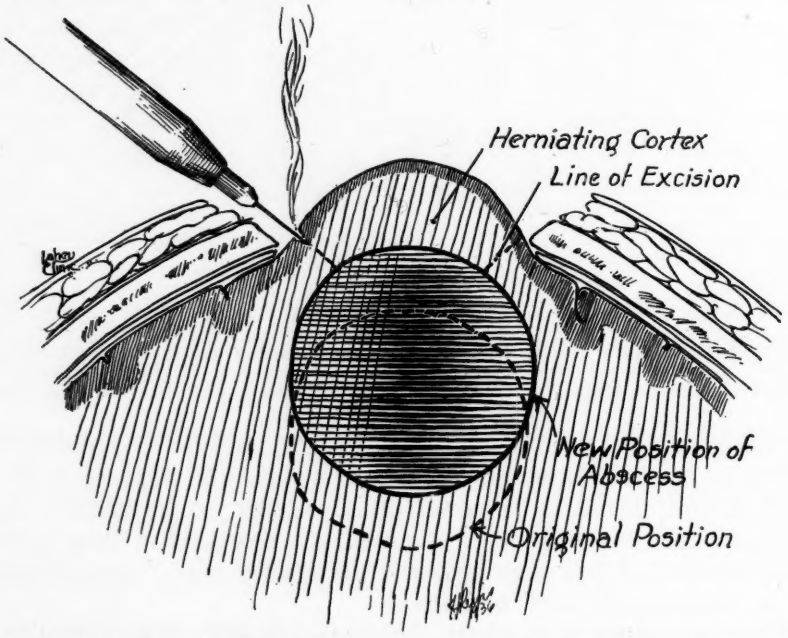

FIG. 384.—Electrosurgical excision of the cortex over an abscess, showing how the abscess itself becomes pushed upward toward the surface with the herniating cortex.

gross contamination of the surrounding exposed brain and meninges by pent-up pus pouring out over them. This is accomplished by the introduction into the

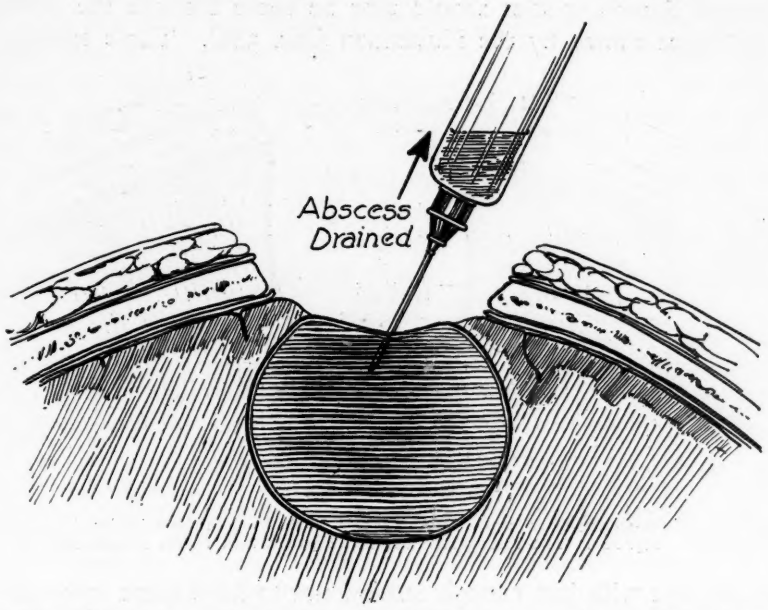

FIG. 385.—Preliminary partial evacuation of the abscess in order to reduce tension and prevent contamination of the surrounding brain when the abscess is opened widely.

abscess of an 18 or 20 gauge needle attached to a syringe and evacuating in this way sufficient pus so that the capsule is collapsed (*Fig.* 385). The needle, still

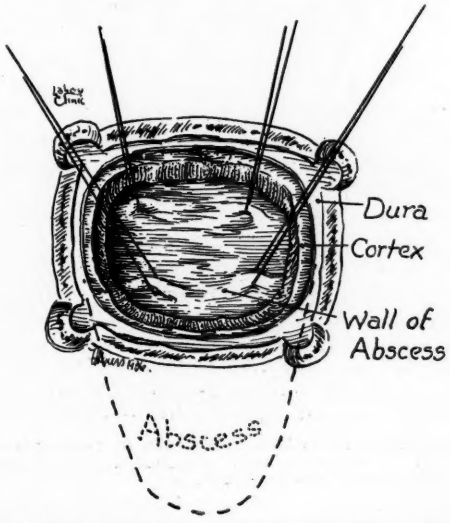

FIG. 386.—Placement of silk stitches in an abscess capsule. The space within the sutures is next opened by wide excision, and the threads then put through the subcutaneous tissues and tied there.

attached to the syringe, is then withdrawn, and the hole left by the needle covered immediately by a small pledget of cotton.

If the abscess capsule is sufficiently thick or firm (and it usually is when the process has been going on from two to four weeks), several stitches of fine silk on fine curved French needles should now be taken through the capsule in the manner and place shown by the illustration (*Fig.* 386). These stitches are held

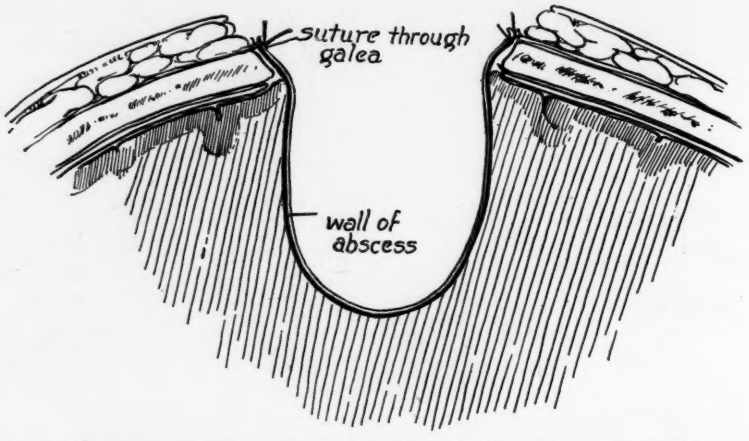

FIG. 387.—Cross-section of abscess showing capsule firmly fixed to the galea by silk sutures which were inserted as in *Fig.* 386. The abscess now becomes a pouch with a wide outside opening.

up by an assistant with just enough tension not to have them tear out. Capsule is then opened widely within the area of these stitches, and the remaining pus evacuated from the cavity by gentle suction. The stitches in the capsule are next

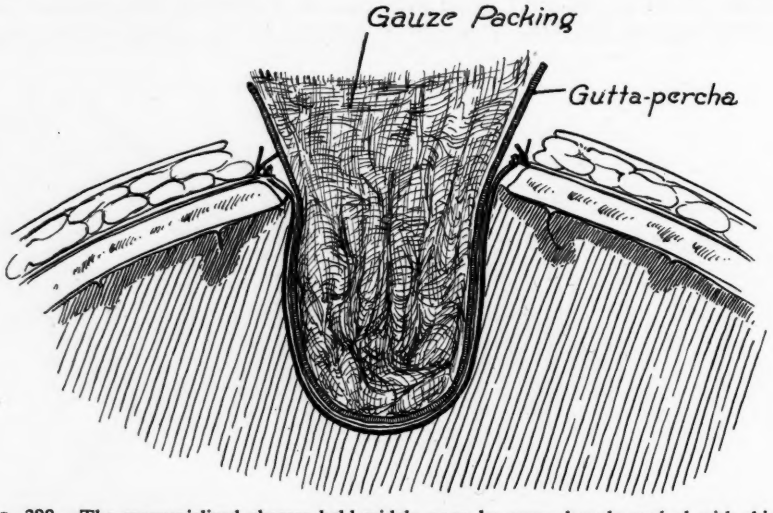

FIG. 388.—The marsupialized abscess held widely open by gauze loosely packed with thin gutta-percha tissue which lies next to the abscess wall. Intracranial pressure gradually pushes this pouch outward until the surface becomes flat and granulates.

sutured to the galea (*Fig.* 387), thus making the mouth of the sac entirely extra-cranial, and as a final step a fairly large tampon of gauze inside gutta-percha tissue is inserted down to the bottom of the cavity (*Fig.* 388).

The whole area of operation is left widely open, scalp vessels being sealed off by coagulation, and a large piece of gutta-percha tissue placed over the entire

field, on which the usual gauze dressing is then arranged. This dressing as a rule is not touched for forty-eight hours, after which it is changed about every two or three days. At first there will be some herniation around the edges in spite of the sutures from capsule to galea. This herniation is usually not great and lumbar punctures for its reduction are hardly warranted. Gradually the area around marsupialized capsule begins to granulate; the gutta-percha tampon is extruded slightly and can be cut off about a quarter of an inch every two days. Finally, the tampon is entirely extruded, the granulating surface is level with the scalp, and epithelium grows over it rapidly from the wound edges. The whole process may take a matter of 8 to 10 weeks, but as a rule the patient may be discharged in 5 to 7 weeks, as any danger is then past and dressings may be taken care of by a local physician.

CASE REPORTS.—The following brief protocols of the nine patients treated by marsupialization give the essential diagnostic, aetiologic, and therapeutic features, together with the end-results.

Case 1.—D. D. (P.B.B.H. Nos. 26177 and 27799), male, aged 7.

AETIOLOGY.—Compound fracture of skull, with subsequent osteomyelitis, in February, 1926. Patient admitted April 17, 1926.

LOCALIZING FEATURES.—Fungus cerebri over right motor area with bony defect by X-ray under fungus. Left hemiparesis. Bilateral choked disks.

TREATMENT.—Abscess under fungus tapped three times and finally drained with catheter. Fungus granulated and healed. Patient discharged July 26, 1926. Returned Jan. 19, 1927, with recurrence of pressure symptoms. Abscess tapped four times, but finally marsupialized March 31, 1927. Cavity contained 70 to 80 c.c. of pus. *Staphylococcus aureus*. Discharged June 4, 1927, well except for some residual weakness of left side.

FOLLOW-UP, April 8, 1929 (2 years after final operation).—General health excellent, attending school, weakness of left arm and slight weakness of left leg.

Case 2.—M. D. (P.B.B.H. No. 28764), female, aged 12. Admitted May 8, 1927.

AETIOLOGY.—Double mastoiditis, Dec. 11, 1926.

LOCALIZING FEATURES.—Jacksonian convulsion five weeks after mastoidectomy Dec. 11, 1926, involving left face and arm. Continuous drainage from left ear. Left hemiparesis and astereognosis. Left lower quadrantal homonymous field defect.

TREATMENT.—Temporo-parietal abscess marsupialized May 13, 1927. Patient discharged July 13, 1927. Some residual weakness of left arm and leg.

FOLLOW-UP, Oct. 31, 1931 (4½ years after operation).—Normal mentally. Some spasticity and weakness of left side. Occasional convulsive seizures for one year.

Case 3.—L. H. (P.B.B.H. No. 28815), female, aged 15. Admitted May 16, 1927.

AETIOLOGY.—Frontal sinusitis in August, 1926. Operations elsewhere for frontal sinus drainage and drainage of frontal lobe abscess in September, 1926.

LOCALIZING FEATURES.—Return of pressure symptoms and cerebral hernia at old operative site, left frontal region. Bilateral choked disks. Right lower facial weakness.

TREATMENT.—Marsupialization of huge, multilocular abscess of left frontal lobe, May 17, 1927. Cavity contained 100 to 120 c.c. of pus. *Staphylococcus aureus*. Discharged Aug. 7, 1927.

FOLLOW-UP, July, 1936 (9 years after operation).—No recurrence of abscess, but patient has fairly frequent grand and petit mal seizures.

Case 4.—R. H. (P.B.B.H. No. 30150), male, aged 10. Admitted Nov. 22, 1927.

AETIOLOGY.—Osteomyelitis of skull—left frontal.

LOCALIZING FEATURES.—X-ray evidence of osteomyelitis of left frontal bone. Right-sided Jacksonian convulsions. Bilateral choked disks.

TREATMENT.—Excision of osteomyelitic bone. Marsupialization of abscess Dec. 8 and 9, 1927. Large multilocular cavity containing 80 to 100 c.c. of pus. *Staphylococcus hæmolyticus.* Discharged Feb. 20, 1928.

FOLLOW-UP, March 12, 1931 (3¼ years after operation).—Patient in excellent health.

Case 5.—H. A. B. (P.B.B.H. No. 37035), male, aged 35. Admitted Aug. 5, 1930.

AETIOLOGY.—Frontal sinusitis in June, 1930. Removal of right turbinate Aug. 12, 1930.

LOCALIZING FEATURES.—Right frontal sinusitis. Tenderness and swelling over right frontal sinus and of right eyelid. Left lower facial weakness. Mental aberration.

TREATMENT.—Removal of sequestra from frontal bone and marsupialization of right frontal lobe abscess containing 30 c.c. of pus, Aug. 30, 1930. *Staphylococcus aureus.* Death on Sept. 4, 1930.

Case 6.—A. F. F. (P.B.B.H. No. 38566), male, aged 14. Admitted April 7, 1931.

AETIOLOGY.—Furuncle of nose Feb. 15, 1931, with spreading cellulitis of face.

LOCALIZING FEATURES.—Tenderness over left supra-orbital region. Right facial weakness. Right pupil larger than left. Choked disks 3–4 D. Ventriculogram showed left frontal lesion.

TREATMENT.—Left frontal abscess marsupialized April 8, 1931 : 100 c.c. of pus. *Streptococcus hæmolyticus.* Discharged May 31, 1931.

FOLLOW-UP, March 21, 1935 (4 years after operation).—Patient living normal life; athletic, up to usual grade in school.

Case 7.—A. M. M. (P.B.B.H. No. 37943), female, aged 12. Admitted Jan. 2, 1931.

AETIOLOGY.—Otitis media and mastoiditis three months before admission.

LOCALIZING FEATURES.—Draining left mastoid wound. Right upper quadrantal homonymous field defect. Choked disks 5D. Right lower facial weakness.

TREATMENT.—First operation, Feb. 2, 1931 : abscess tapped. Second operation, eight days later, Feb. 10, 1931 : abscess marsupialized as patient did not improve. *Staphylococcus aureus.* Discharged March 29, 1931.

FOLLOW-UP, Dec. 12, 1931 (10 months post-operative).—Patient in excellent condition.

Case 8.—M. P., female, aged 10. Admitted to N. E. Baptist Hospital, Sept. 25, 1933.

AETIOLOGY.—Abscess of nasal septum, Sept. 1, 1933.

LOCALIZING FEATURES.—None. Ventriculogram showed situation of abscess in left frontal lobe.

TREATMENT.—Marsupialization of abscess Sept. 29, 1933. Large cavity containing 60 to 70 c.c. of pus. *Staphylococcus aureus.* Discharged, Oct. 31, 1933.

FOLLOW-UP, September, 1934 (1 year post-operative).—In excellent condition : attending school.

Case 9.—A. S. (L.C. No. 39957), female, aged 5. Admitted to N. E. Deaconess Hospital, May 4, 1934.

AETIOLOGY.—Not certain, probably upper respiratory infection.

LOCALIZING FEATURES.—Jacksonian convulsions involving left face. Paresis of left arm, face, and leg. Choked disks 1D.

TREATMENT.—Right osteoplastic craniotomy on May 17, 1934, as lesion was thought to be tumour. Encapsulated right frontal lobe abscess encountered. Marsupialization of abscess, containing 80 to 100 c.c. of pus. Organism probably *Staphylococcus aureus,* but culture showed only diphtheroids. Discharged July 14, 1934.

FOLLOW-UP, June, 1935 (1 year post-operative).—Child in excellent condition except for slight weakness of left arm.

As observed previously, only two procedures aside from marsupialization need be mentioned in the treatment of chronic encapsulated brain abscesses. These are: (1) Tapping—single or repeated punctures of the abscess with evacuation of the pus by this means; and (2) Extirpation of the abscess *en bloc.*

Tapping.—Four of the cases in this series were treated by tapping only, with no deaths; but as will be seen subsequently, several others in whom taps had been tried eventually needed more radical treatment. Three of these patients required repeated tappings before they were cured, whereas one, a cerebellar abscess, has remained perfectly well for four years after a single evacuation of her abscess by this means. Examination of the pus from all patients in the group which were tapped showed organisms by smear, but no growth could be obtained by culture.

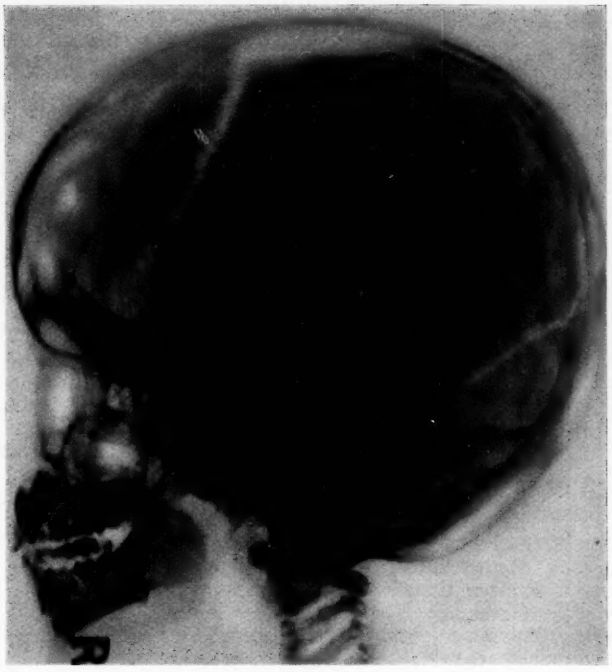

FIG. 389.—Chronic brain abscess with entirely calcified wall, healed successfully by extirpation.

Extirpation.—In three patients complete extirpation of the abscess was carried out successfully, and although there were no deaths by this method it must always be considered a potentially dangerous procedure. Vincent,[12] in an important communication during the present year, called attention to this method preceded by decompression as being particularly applicable in subacute abscesses, and from his description it would appear that it is undoubtedly the ideal way of treating abscesses of this type. The cases in the present series, however, were all of the chronic variety. In one patient at the Children's Hospital, Boston, the abscess wall was entirely calcified, the only example of such a condition in my experience (*Fig.* 389). The lesion was believed to be a tumour before operation.

DISCUSSION

In *Table II* there is given a summary of the various operative procedures together with the end-results in the 18 patients in whom a single encapsulated abscess was found. Sufficient has been said already regarding the technique as

well as the efficacy of the method of marsupialization. Certain comments, however, should be made concerning simple tapping and radical extirpation of a brain abscess.

Table II.—Chronic Encapsulated Brain Abscesses: Methods of Treatment and End-results in 18 Cases

Case No.	Sex	Age	Method of Treatment	Location	End-results, with Time Since Operation	Disability, if any
1. D. D.	Male	7	Marsupialization	Right motor area	Improved, 2 yr.	Some weakness of left arm and left leg
2. M. D.	Female	12	Marsupialization	Temporo-parietal	Improved, 4½ yr.	Some weakness of left side. Convulsions, 1 yr.
3. L. H.	Female	15	Marsupialization	Left frontal	Improved, 9 yr.	Convulsions
4. R. H.	Male	10	Marsupialization	Left frontal	Well, 3¼ yr.	None
5. H. A. B.	Male	35	Marsupialization	Right frontal	Died	
6. A. F. F.	Male	14	Marsupialization	Left frontal	Well, 4 yr.	None
7. A. M. M.	Female	12	Marsupialization	Left temporal	Well, 10 mth.	None
8. M. P.	Female	10	Marsupialization	Left frontal	Well, 1 yr.	None
9. A. S.	Female	5	Marsupialization	Right frontal	Well, 1 yr.	Very slight weakness of left arm
10. G. E. K.	Male	6	Repeated tapping	Left frontal	Well, 2 yr.	Some reduction in vision from secondary optic atrophy
11. J. A.	Male	40	Repeated tapping	Right parietal	Well, 1 yr.	None
12. B. O.	Male	10	Repeated tapping	Left frontal	Well, 1 yr. 10 mth.	None
13. P. R.	Female	14	Single tap	Left cerebellar	Well, 3 yr.	None
14. M. M. W.	Male	28	Extirpation	Left frontal	Well, 2 yr. 3 mth.	None
15. J. T. C.	Male	26	Extirpation	Right temporal	Well, 5 mth.	Died from other cause
16. F. J.	Male	4	Extirpation	Right parietal	Well, 5 yr.	None
17. T. J. O'D.	Male	50	Rubber tissue drainage	Right temporal	Died	
18. E. R. P.	Male	17	Negative cerebral tap	Left frontal	Died	

From a glance at the table it will be noted that all four patients who were treated only by single or repeated tappings recovered and were well from one to three years subsequently. This does not tell the whole story, however, since three of the patients who eventually came to marsupialization received one or more taps, and did so badly by this method that there is no doubt they would have died unless the more radical procedure had been carried out. In this case the mortality from tapping only would have been 43 per cent instead of zero. On the other hand, I am inclined to agree in certain particulars with Dandy, who has so forcefully advocated this method, when he says that in general one should do as little as seems necessary in the presence of a single encapsulated abscess. It is possible that tapping should always be tried first, but I feel that it is potentially dangerous for two reasons. In the first place, other foci of infection may be started along the track of the needle as it is withdrawn; and in the second place, even after an abscess has been tapped it may refill so rapidly as to cause sudden increased intracranial pressure and even death before proper measures can be instituted. Furthermore, King[13] (1936) included a significant statement in an excellent article dealing with the subject in hand. He says: "Recently I saw sections of three brains

which had been removed from patients who had been operated upon consecutively by one of my colleagues according to this method [tapping]. He told me of the autopsy findings in a fourth case. He has given up the use of this type of operation." Cairns[10] likewise says of tapping: "We have not found this satisfactory". On the other hand, Vincent makes use of repeated taps while waiting for abscesses to encapsulate more thoroughly, but it is intimated that further treatment is usually necessary. Grant, in discussing a paper by Kahn,[14] reports the recovery of 5 out of 7 cases from tapping, but this is a mortality of 28 per cent, which is nearly three times greater than the rate given by Macewen, who used open drainage, and more than twice that of our marsupialized cases.

Vincent and his associates are the most ardent exponents of complete extirpation of well-encapsulated brain abscesses, and their results have been most striking. Puech, Eliades, and Askenasy[15] (1935) reported 8 cases treated by this method, with no deaths from infection, but 2 of the cases died from other causes. My own experience with actual extirpations has been extremely limited, but if it can be accomplished successfully, without drainage, there is no doubt that much time can be saved in hospitalization, for the patient. In the 3 patients of our series drainage was instituted, and, although they all recovered, their course in hospital was as long as the patients treated by marsupialization.

CONCLUSIONS

1. The study of a series of 30 brain abscesses covering a period of nine years is presented.

2. The series is divided into two distinct groups, which differ radically from each other both as to their clinical course and classification, their operability, and their prognosis.

3. In the first group—acute and multiple, often metastatic abscesses, usually having severe systemic or pulmonary complications—the outcome is probably always hopeless.

4. In the second group—chronic single, usually encapsulated, abscesses—the prognosis should be favourable, with a mortality not exceeding 10 to 20 per cent, instead of the generally accepted death-rate of 30 to 40 per cent.

5. A discussion of present-day operative methods employed in the treatment of brain abscesses is given, together with certain details of the technique known as 'marsupialization', which is here regarded as the treatment of choice.

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TORSION OF THE TESTICLE AND OF THE HYDATID OF MORGAGNI

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TORSION of the testis or axial rotation of the testicle on the spermatic cord has long been recognized as a clinical entity, but it has tended to be regarded as a rarity. Abeshouse[1] in 1936 collected 156 cases, including 3 of his own, in addition to 194 reported by Muschat and Carp.[2] Torsion of the hydatid of Morgagni was first recognized in 1922. Roche[3] has recently summarized the literature.

Of the cases here reported, *Cases* 1–4 occurred in 1934–35 in a school of 650 boys, and *Cases* 5–9 in a school of 600 during the period 1933–37.* The condition is therefore sufficiently common to warrant its being kept constantly in mind in the diagnosis of abdominal or testicular pain.

CASE REPORTS

Case 1.—**Torsion of testicle, with subsequent complete atrophy.**—

A boy of 14 years 8 months was admitted on Feb. 12, 1935, with pain and swelling of the right testicle. He had noticed the pain the previous evening, soon after playing hockey, but he did not recollect its having been struck or injured in the game. The swelling was first noticed on the morning of Feb. 12. He had had mumps at his preparatory school.

On examination, the right epididymis area was tender and swollen. There was no hydrocele: the cord was normal. Tongue clean. Temperature was normal in the morning, and 99·4° in the evening. Next day the temperature was 99·4° in the morning and 99·6° in the evening. More general swelling of testis and epididymis; slight œdema. Urine showed no abnormality. On Feb. 14 and 15, testis and epididymis still red and tender. Slight acute hydrocele present. He ran a temperature, usually 99° to 100°, until Feb. 17. On the 17th, swelling and tenderness began to decrease; on the 20th there was a slight fluid swelling in front of the epididymis, which was still rather tender. He went home on March 3 with testicle practically normal. Subsequent examination showed complete atrophy of the testicle.

Case 2.—**Recurrent torsion of testicle, with possibly spontaneous untwisting in early attacks, and subsequent partial atrophy.**—

A boy, aged 14 years 10 months, was admitted on Oct. 11, 1935, with a history of rapidly increasing pain in the left testicle. This had started fairly suddenly an hour previously. He felt sick, was obviously in acute pain, and was very pale, sweating, and collapsed. His rolling about in agony suggested an attack of renal colic. There was a history of a previous attack of short duration and much less severity two terms ago; this had passed off quickly.

On examination, the left testis was very tender, and there was some slight swelling in the upper pole. The spermatic cord was not swollen, painful, or tender. The pain was so acute that an injection of morphia, gr. $\frac{1}{6}$, and atropine, gr. $\frac{1}{100}$, was given at once. He

* Two of the latter have already been reported.[4] The histories subsequent to 1935 have been added.

slept soon after this, and in a few hours all pain, tenderness, and swelling had gone. No pyrexia throughout. On Oct. 13 he was discharged to school.

He was again admitted (aged 15 years 2 months) to the Sanatorium on Feb. 29, 1936, with an exactly similar history and condition of acute pain, collapse, tenderness, and swelling in the upper testicular region. After injection of morphia and atropine his condition passed off, and he was discharged to school on March 2.

At home in the Christmas holidays, on Dec. 29, 1936, he had a similar very acute attack of pain, followed by a large swelling of the left testicle, with œdema and redness of the scrotum—the cord was tender and swollen up to the external abdominal ring. He was seen by Mr. Gaymer Jones, F.R.C.S., of Windsor, who reported: "It was impossible to be sure of the diagnosis, but I felt fairly sure that it was mechanical in origin and that there was an associated interference with the blood-supply of the testicle, this being chiefly in the venous side. I think the condition I saw must have involved the whole testicle." It was decided to operate immediately should another attack take place, to find out the exact cause and if possible prevent recurrences.

On his return to school in January, 1937, the left testicle was still slightly enlarged and tender. This gradually subsided during the term. Examination in June, 1937, showed marked atrophy of the testicle.

Case 3.—**Torsion of hydatid of Morgagni giving rise to torsion of cord; operation.**—

A boy of 17 had a sudden attack of pain in the left testicle at about 5 a.m. on Feb. 12, 1934. He reported at 8 a.m. with nausea and testicular pain. There was no history of trauma.

On examination he was rather pale; there was some swelling and marked tenderness of the upper part of the epididymis, but no redness or œdema. No frequency of micturition or dysuria. Urine acid; no albumin, sugar, or deposit. No meatal discharge. The spermatic cord was not swollen or tender. Right testicle normal. Temperature normal: that evening rose to 100°. Next day the testicle and epididymis were generally swollen. This swelling persisted, although the tenderness gradually subsided. He ran a slight pyrexia, the evening temperature usually being 99·5° to 100°, until Feb. 22, when he was seen in consultation with Mr. J. L. Joyce, F.R.C.S., who suggested the diagnosis of acute tuberculosis of the testicle. He had a gland scar in the neck and there was defective air entry at the left apex. Next day he went home to Edinburgh, and was seen by Sir John Fraser on Feb. 28, who reported as follows:—

"The condition of the left testicle is an unusual and interesting one, and while it might well be that a tuberculous infection of the testicle is the explanation, I think it is possible that the evidences may be the result of torsion of the spermatic cord. I feel that the sudden onset of the disturbance is a significant feature, while the clinical evidences point to the fact that there is a good deal of hæmorrhagic effusion in both testis and epididymis: there is also an entire loss of testicular sensation."

On March 1 he reported: "This boy was operated on this morning. We found that the left testicle and epididymis were the site of a torsion of the cord so that the organs were in a condition of complete necrosis. The sac of the tunica vaginalis was filled with blood-stained fluid. The testis was removed."

On March 9 a further report was sent: "This boy has made a very good recovery. With regard to the exact nature of the disturbance, a further investigation of the specimen indicates that the torsion actually began in the appendix of the testicle, which in this case was provided with an unusually complete and long pedicle. From this focus it extended until the testis and epididymis were completely involved."

Case 4.—**Torsion of hydatid of Morgagni.**—

Admitted on Feb. 25, 1935, with abdominal pain of colicky type referred to the umbilicus and right iliac fossa. It began abruptly at 5 a.m., while in bed. Bowels were opened that morning. Pulse 64; temperature 97°.

On examination, no deep tenderness was evident in the right iliac fossa or abdomen. There was no history of a previous similar attack. At 6.45 p.m. he vomited once. Temperature was 97·6°. At 9 p.m. there was still pain, and on examination the right testis was a hard, irregular mass the size of a hazel-nut in the upper epididymis region. There was no

swelling or tenderness of the spermatic cord. Temperature was 97·8°. On the next two days temperature and pulse were normal, and all evidence of any pain or tenderness or swelling of the testis had gone. He was discharged to school on Feb. 27. As he has left school, further follow-up was not possible.

Case 5.—**Recurrent torsion of the spermatic cord, treated repeatedly and successfully by non-operative manipulation—no subsequent atrophy.—**

An active, well-developed boy, aged 14 years 2 months, was awakened at 4 a.m. on Nov. 20, 1932, with severe pain in the left lower abdomen. This had kept him tossing about the rest of the night, and when seen at 9 a.m. the testicle was found to be very hard, but not exquisitely tender. The cord appeared normal. Puberty was advanced. By rotating the testicle 360° from the boy's left to right upwards, all his symptoms disappeared, and by evening the testicle was normal in size. His pulse was 70 throughout, his temperature 99° in the evening.

His father, who was a doctor, in answer to the questionnaire that all parents fill in before boys enter the school, had reported that "from 5 to 7 years of age he had occasional short attacks of abdominal pain; no diagnosis made except indigestion". The boy gave a clear history of an attack, less severe than the one witnessed, at his preparatory school in July, 1932 (i.e., when aged 13 years 9 months).

In January, 1933, he had a third attack while in bed. He called his father, who was able to relieve him by the same manipulation. He went to sleep again, and was well the following morning.

He has had four or five further attacks, always at night. They wake him, but he has no difficulty in untwisting the testicle by rotating it 360° from left to right. There is no atrophy.

He still gets periodic attacks, perhaps three or four a year, but the intervals are getting progressively longer. The last attack is the only one which occurred in the daytime (March, 1937). On this occasion, by rotating the testicle 180°, symptoms were relieved. On the other occasions, the pain has wakened him up at night. The testis was always swollen and required rotation through 360° to relieve the pain. The untwisting is always in the same direction. There has been no atrophy (June, 1937). His father, after consulting a surgeon, decided against orchidopexy.

Case 6.—**Torsion of spermatic cord: non-operative untwisting; no atrophy; subsequent orchidopexy.—**

In January, 1933, a somewhat obese, non-athletic boy, aged 14 years 2 months, was under observation for a vague abdominal pain, which he localized to the right iliac fossa. There were no constitutional or physical signs. His testes were actually inspected and found normal. In the next holidays his alimentary canal was X-rayed, but nothing positive discovered. Puberty was advanced. On Oct. 17, 1933, he was awakened at 5.30 a.m. with excruciating pain referred to a point one-third along a line joining the anterior superior iliac spine to the umbilicus. He was very restless and writhing in agony at 6.45. The right testicle was of the size of a hen's egg, and moderately tender. On rotating his testicle 180° from his left to right and upwards, he volunteered the statement, "That's better", but it required a further 180° before complete relief was obtained. He was left to hold it in this position for an hour. Three hours later the testicle was normal in size, although it and the distal inch of the spermatic cord were slightly tender. He thought that the previous attack was of the same nature, except that spontaneous cure had taken place. No subsequent attacks and no atrophy occurred prior to 1934, when he had the testicle fixed in the scrotum. Before operation it lay with its long axis horizontally in the scrotum. The left testicle had a considerable vaginal hydrocele.

Case 7.—**Torsion of the spermatic cord: no operation; subsequent atrophy of testicle.—**

In September, 1933, a well-developed boy of 17 slid down a mountain on his buttocks. Five days later, as he got out of a dentist's chair after having had a painful stopping done, he felt a slight twinge in his right testicle. Bicycling made this worse, and on arrival home he found it was "a little hard". Later in the day he went to London by car, the journey

taking an hour. On arrival he vomited. The pain increased, and he could not eat his lunch. When he returned home he found the testicle swollen, but the pain was relieved by a hot bath and a hot-water bottle in bed. He had a fair night, with occasional twinges on movement. Next day, although he was up, he remained quiet, but the testicle increased in size. Despite the heat from the bath and hot-water bottle, he spent a restless night, and next day his family doctor was consulted, who ordered frequent belladonna plasters, changed after forty-eight hours to hot antiphlogistine compresses, and absolute rest in bed. By this time the swelling was the size of a large duck's egg.

From the fourth day onwards the swelling began to subside, and by the fifth day all pain had disappeared. After a fortnight the testicle was about twice normal, but further decrease in size was very slow. The testicle gradually became harder and smaller, and in June, 1934, was completely atrophied. After five weeks in bed, and after four days' walking about, he returned to school with little disability.

Traumatic orchitis was the initial diagnosis, but the course of the disease is much more compatible with acute torsion.

He also had a large varicocele on the opposite side. The boy's ambition was to go into the Army, but he wisely refused to have an operation on the varicocele to secure possible entrance.

Case 8.—**Torsion of testicle; persistence of swelling and pain, despite untwisting the cord; operation; no atrophy.—**

On Feb. 10, 1937, a boy of 14 woke up at 4.45 a.m. with severe ache in the right testicle, which was fully descended. He had his bowels opened at 5 a.m. without relief. He was first seen at 6.10. The diameter of the right testicle was about double the left. The tone of the dartos was completely lost. The epididymis was in front. The testicle was rotated 180°, the epididymis rotating outwards and back. This gave temporary relief of pain, but further manipulation failed to give additional relief. By 6.45 there was no diminution in size or in pain, and it was decided to operate. From 6.45 to 7.15 he was groaning in agony, but after a full dose of morphia the pain settled down, although there was no decrease in size. The cord appeared normal.

At 9 a.m. he was seen by Mr. F. A. R. Stammers, who agreed that the signs and symptoms pointed to a torsion having taken place, and also that since manipulation had failed to relieve pain or to be followed by diminution of swelling, exploratory operation was urgently needed. Under general anæsthesia the testicle was exposed, and was twice the diameter of its fellow. There was no evidence of a twisted cord, but there was a fairly large hydrocele, which was not present during the routine examination as a new boy three weeks previously. The sac was removed and the testicle fixed in the scrotum in the same position as it was found. The hydatid of Morgagni, which was in its normal position, was removed as a preventive measure.

It is difficult to explain the persistence of the pain, which was probably due to the considerable venous congestion inside the tough tunica albuginea. There was very little tension in the hydrocele. The wound healed well. At the end of a week, the testicle was about one and a half times its fellow: at the end of the month both were equal.

When re-examined in June, 1937, both testicles were equal and of normal size.

Case 9.—**Torsion of hydatid of Morgagni.—**

A boy of 15 was admitted on May 15, 1935. At lunch time on the previous day he had had pain in the right testicle, and by evening this had become fairly severe. He did not report till twenty-four hours later, when the right testicle was generally tender, but particularly at its upper pole. There was no enlargement. An ice-bag was applied. The skin of the scrotum on the right side was markedly thickened and puckered, due to contraction of the dartos muscle on that side. Next day this had disappeared, and through the thin scrotal skin a bluish swelling the size of a pea could be seen at the upper pole of the testis. The tenderness had practically disappeared. The following day the lump could still just be seen, but it was no longer blue. No temperature or vomiting throughout; urine normal.

On Oct. 2, 1935, he complained of an ache in his right testicle. He was very slightly tender over the organ of Morgagni, but next day was perfectly well.

SYMPTOMATOLOGY

Torsion of the Testicle (6 cases).—The symptoms may be divided into local, referred, and constitutional. In 4 cases pain was referred to the testicle itself; in 2 to the iliac fossa on the same side as the affected testicle. The general symptoms differed considerably from the text-book. Vomiting occurred in only one case, and nausea in another. In the former the testicle ultimately became as large as a duck's egg, and we are therefore justified in assuming that there was a sudden and large increase in the tension in the tunica albuginea, etc. The boy who complained of nausea also had considerable swelling of the testicle. The nausea was present only in his third observed recurrence.

A striking feature noted repeatedly by both of us was the "agony" and restlessness, symptoms usually associated with attacks of colic. Equally striking is the relief obtained by restoring the testicle to normal by manipulation (except in *Case* 8), and to a less extent after giving morphia. The mechanism of this latter phenomenon is not clear. The tension is probably irritated by muscular contractions of the cremaster. Possibly the relief of pain diminishes these contractions and allows, in some cases, spontaneous untwisting, in others a diminution of the venous engorgement.

Recurrent torsion and spontaneous recovery seem to be of fairly frequent occurrence. The significance of this will be discussed later under the heading of treatment.

Torsion of the Hydatid (3 cases).—The appendix of the epididymis, the paradidymis (organ of Giraldès), and the vas aberrans of Haller are capable of becoming twisted, but practically always the hydatid of Morgagni is the only appendix to the testicle and epididymis to suffer this fate. In *Case* 3 special care was taken by Sir John Fraser in identifying the twisted organ as the hydatid of Morgagni.

These three cases show various degrees of severity. The size of the hydatid and length of pedicle are chiefly responsible for the variations. Pain was referred to the umbilicus and right iliac fossa in one; to the testicle in the other two. In one it was localized to the upper part. Nausea occurred in *Case* 3 and vomiting in *Case* 4. One (*Case* 3) had a low-grade pyrexia commencing twelve hours after onset. The scrotal skin in *Case* 9 was puckered, probably reflexly from contraction of the dartos.

The general signs differed little from those seen in torsion of the spermatic cord, and differential diagnosis between the two conditions must depend on accurate interpretation of local signs.

DIFFERENTIAL DIAGNOSIS

One of the outstanding points in the history of these attacks is the failure of the boy to complain of pain in the testicle itself, but to refer it to the abdomen. Appendicitis may in this way be mimicked. If the pain is localized to the scrotum, the suddenness of onset and the rapid increase in size of the testicle point to a mechanical cause, and the low temperature and slow pulse to the absence of an acute infection, whether this be the orchitis of mumps or of a pyogenic or tuberculous origin. A strangulated hernia must be excluded. In the early hours after

torsion, the pain will be limited to the testicle, which, though possibly very tender, will be definable. A strangulated hernia, seen later, will have signs of intestinal obstruction. In all our cases the testicle was in the scrotum, so that inguinal adenitis, etc., were not possibilities.

A condition which might be expected to simulate torsion is thrombosis of, or hæmorrhage from, the pampiniform plexus. The onset is, however, far less acute in the latter. McGavin describe two cases: "Five weeks before admission the first began to feel pain in his left testicle, and this pain was increased by coughing or by lifting heavy weights". In the other, four weeks before admission there had been a sudden onset of severe pain in the left testicle. The testicles in both cases were removed because tuberculous epididymitis was suspected, but pathological investigation showed the condition to be caused by thrombosis of the veins of the plexus.

The following is the only case seen by one of us (R. E. S.) in six years at a school of 600 boys:—

On Oct. 26, 1935, a boy of 15 years 6 months came to the Sanatorium with a large swelling in the left groin, which he had noticed when he put his hand in his pocket during the game of football. There was a diffuse swelling about the size of an egg over the external inguinal ring, but there was no impulse on coughing. He had a slight pain over the inguinal canal. He was put to bed and an ice-pack was placed over it and gentle manipulation applied in order to reduce the supposed hernia. This, however, was impossible, and next day there was a small hæmatoma over the swelling. He was taken to London by car, and seen by Mr. W. H. Ogilvie. By this time (i.e., thirty-six hours afterwards) there was a large hæmatoma of the left half of the scrotum, which was quite black. The inguinal canal was diffusely swollen, without any circumscribed lump like a hernia. The swelling gradually subsided, and later the spermatic cord could be felt as a hard ridge running down the canal, which was thought to be organizing hæmorrhage which had come from a ruptured vein of the pampiniform plexus inside the infundibuliform fascia.

There was very little to see a fortnight later, except slight staining, and the cord felt a little thickened. The testicle was normal from beginning to end.

TREATMENT

The whole object of treatment is to save the testicle. Abeshouse states that there is no report of a death resulting from torsion of a testicle. In the acute attack, three lines of approach are open.

Firstly, an attempt at reduction should be made by non-operative measures. The testicle is held gently in the hand and twisted from within, outwards and upwards. Any increase in pain means that the twist is being exaggerated and the procedure must be reversed. Rotation through 180° may produce relief. The patient if intelligent will be able to say when the twist is completely undone, or, as sometimes happens, the testicle finishes the untwisting of its own accord once detorsion has been initiated artificially. Torsion had occurred five hours before it was relieved in *Case* 5. No atrophy occurred. *Case* 8 was disappointing, in that untwisting failed to give relief. If there is any doubt whether the manipulation has been satisfactory, the obvious alternative is operation. Spontaneous untwisting undoubtedly occurs in a large proportion of cases, but no one on this account would postpone operation on a case where manual manipulation had failed.

Secondly, operation should be advised when the testicle cannot be untwisted

and when there is a chance to save it. No hard or fast rule can be laid down as to when a testicle is no longer viable. The severity of the torsion is a cardinal factor. Borderline cases must be explored, and the surgeon will judge each testicle on its merits.

Thirdly, there will obviously be a group of testicles which the surgeon cannot hope to save. *Case* 7 is in this category, because the patient did not report his trouble for forty-eight hours. We see no reason why, unless suppuration appears imminent, these should not have expectant treatment as Howard and Rigby[5] advised in 1907.

A further question to be settled is: Should all testes which have undergone torsion and been relieved by manipulation, be fixed surgically in the scrotum? The answer in our opinion is that the facts should be explained to the parents, or to the patient if of riper years. Although recurrence is common, we are not at present able to say if it usually continues throughout life. There is a possibility that the anatomical defects which predispose to torsion are different in the cases which recur from those in which a single catastrophe occurs.

Torsion of the hydatid of Morgagni is seldom a serious condition. Although Roche advocated operation in his case, he told the mother that operation was not essential. This was equally true in our *Case* 9, but obviously *Cases* 3 and 4 called for surgical judgement.

Case 4 resembles in many ways one reported by Michell and Nicolleau.[6] On exploration they found the hydatid twisted, and the testicle and epididymis very enlarged; but ligature of the hydatid at its base was followed by the subsidence of symptoms.

French authors, and especially Mouchet,[7] were the first to focus attention on this condition. Nevertheless, their terminology "orchite subaiguë de l'adolescence par torsion de l'hydatide sessile de Morgagni" seems open to criticism. That the vast majority of cases occur in adolescence is undoubted, but there is often no inflammation at all in the testis proper, and there was none in the two cases Mouchet himself reports. At the same time, the term emphasizes the possibility that torsion of the hydatid can interfere with the blood-supply in its neighbourhood and cause necrosis. However, we believe that careful clinical examination should be able to decide if this has occurred. If any doubt arises an immediate exploratory operation should be advised.

AGE INCIDENCE

The onset of puberty has been held to cause a congestion of the testicle and the hydatid of Morgagni, and so to be a contributory aetiological factor. This series lends some support to this view, although it must be remembered that all the 1250 boys under our observation are between 13 and 18. Abehouse's figures of the age incidence do not suggest that puberty is a strong contributing factor. In his collection of 156 cases, 22 were between 11 and 15, and 38 between 16 and 20, or more than double those in any other decade after the first year—24 occurred in children less than one year.

In the routine examination of boys (which includes inspection of the testicles) an atrophied testicle due to torsion has not been discovered.

Our observations offer no new theory to explain why torsion takes place.

SUMMARY

Six cases of torsion of the testicle and three of the hydatid of Morgagni are described.

The symptomatology in all presents a fairly clear-cut clinical picture. Diagnosis between torsion of the main organ and the appendix depends on accurate interpretation of the local signs.

The treatment falls into three groups :—

1. Reduction by non-operative manipulation, followed by fixation in the scrotum if required.

2. Immediate operation if (1) fails.

3. Expectant treatment if the testicle appears beyond the hope of salvation, and if suppuration does not appear imminent.

We are indebted to the surgeons mentioned in the text for their help and for permission to publish their findings.

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THE SURGERY OF THE PINEAL ORGAN

By CECIL P. G. WAKELEY, London

INTRODUCTION

Although the pineal organ in man has caused speculation as to its function from the earliest times, yet it is only of recent years that any interest has been taken in it from a clinical and practical point of view. Galen considered that it was a gland, and that its function was similar to other glandular structures in the body. Descartes, in 1662, considered that the pineal was the seat of the soul. The pineal gland was known to contain calcium salts, but it is only some twenty years ago that calcification in the pineal was first demonstrated in an X-ray plate; and to-day about 70 per cent of adult skulls show a calcified pineal. With improved technique in radiology the percentage will be still further raised. This trivial and somewhat

Fig. 390.—Lateral radiograph of the skull of a patient, aged 50, showing the typical appearance of calcification of the pineal gland.

unimportant fact has proved of value to the diagnostician confronted with a difficult cerebral tumour which is not localizable on clinical grounds. The pineal, being a midline organ, will be deflected to the right or left by an expanding tumour in its vicinity. If a direct antero-posterior X-ray is taken and the calcified pineal can be seen to be displaced (pineal shift), it will at once give the side of the tumour which has caused deviation to the opposite side.

The calcification of the pineal appears as an irregular amorphous deposit of calcium salts forming a shadow about the size of a grape pip (*Fig.* 390). The choroid plexus may be calcified on one or both sides, but such a condition only occurs in 5 per cent of adults (*Fig.* 391). The calcification is always greater than that of the pineal, and on an average it is about the size of a pea, although it may be mistaken for a calcified pineal in a lateral radiograph. Stereoscopic

radiographs will always differentiate the two conditions; also, in the postero-anterior view of the skull the choroid plexus is situated about an inch from the midline, just above the orbit.

FIG. 391.—Lateral and antero-posterior radiographs of skull, showing calcification in the choroid plexus.

Pineal cysts and tumours have only proved of clinical interest of recent years. The first real discussion on pineal tumours took place at the Royal Society of Medicine in 1909, when the subject was introduced by Hinds Howell. Gordon Holmes stated at the meeting that he thought that surgical removal would be practicable in these cases, and Sir Victor Horsley said that he would operate on the next case that came his way by a supratentorial route. Records, however, do not relate if Horsley ever operated upon a pineal tumour.

ANATOMICAL CONSIDERATIONS

Before considering the surgery of such a structure as the pineal gland, it will be profitable to review shortly the anatomy, development, and morphology of this very interesting part of the brain. It is only by so doing that we can hope to interpret signs, syndromes, and symptoms, and also to differentiate the various histological pictures that are met with in tumours that arise in the pineal and call for surgical intervention.

The pineal organ or epiphysis of the human brain resembles a minute pine-cone, and springs from the posterior part of the roof of the third ventricle. It lies in a depression between the superior corpora quadrigemina, which form its relations inferiorly. Above, it comes into contact with the velum interpositum

and the splenium of the corpus callosum. The apex of the pineal is quite free, and is directed downwards and backwards, while its base is directed in the opposite direction, and helps to form the posterior boundary of the cavity of the third ventricle (*Fig.* 392).

Histologically, it consists of a mass of rounded epithelial cells which are arranged in an alveolar manner. But there is quite a change in the character of the

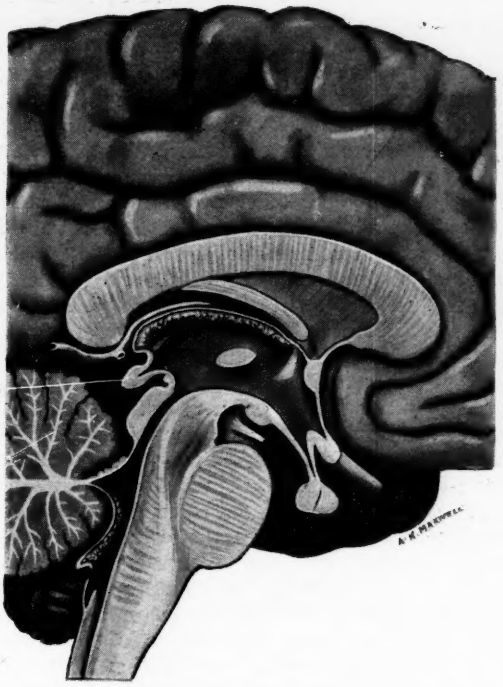

FIG. 392.—Anatomical relationships of the pineal gland.

cells if sections of the gland are studied in the different periods of ante-natal and post-natal life. Between the alveoli or follicles there is a supporting stroma containing blood-vessels and deposits of calcareous salts, consisting of calcium carbonate, magnesium phosphate, and ammonium phosphate. Owing to the presence of these salts, calcification frequently takes place in the gland and renders it opaque to X rays.

EVOLUTIONARY ASPECTS OF THE PINEAL ORGANS AND HABENULAR REGION

The pineal organs and the structures in relation with them are of the greatest interest from the historical and evolutionary aspects. Further, they are of great practical importance, since various kinds of tumours and cysts may originate in this region, and give rise to symptoms due to pressure on, or destruction of, neighbouring parts. Paralyses or spastic contractions of muscles, affecting more especially the orbital muscles, and obstructive hydrocephalus due to blocking of the aqueductus cerebri, may be quoted as examples.

The pineal organ and related structures are present throughout the whole vertebrate series, being well developed in such types as the cyclostomes, all higher types of fishes,

amphibia, reptiles, birds, and mammals. In many extinct reptiles a large parietal foramen is present in the skull similar to that of certain living species such as sphenodon, and it is inferred that the parietal sense organ or 'pineal eye' was highly developed in these animals, and that it was probably sensitive to light. Among living forms it is found most highly differentiated in sphenodon (*triatura*) and other lizards. In these animals the 'pineal eye' is situated in the parietal foramen beneath a translucent epithelial plate (parietal plug). The parietal organ possesses a superficial lens-like structure, beneath which is a vitreous-like body, and a sensitive epithelium which contains pigment granules (retina). The parietal organ and the associated parapineal body are connected by special nerves with the right or left habenular ganglion, the superior and posterior commissures, and the fasciculus retroplexus of Meynert.

Although the pineal gland of the adult human subject appears to be a simple unpaired median structure, it has been considered by Hill, Locy, Dandy, and Cameron that in lower vertebrates (fish, amphibia, reptiles, birds) it originates ontogenetically as a bilateral or paired organ. One of the two primary vesicles which represent its earliest stage of development is vestigial and either disappears or is modified to form a glandular structure, namely, the 'parapineal organ' or 'epiphysis'; the other in certain reptiles becomes differentiated as the 'pineal eye' or 'parietal organ'. In the amphibia, reptiles, and some higher vertebrates the primarily left pineal diverticulum becomes developed as the 'parietal eye', while in certain fishes the right diverticulum undergoes development, and the left becomes vestigial. As a result of an exhaustive study of the development of the pineal region in geotria, the New Zealand lamprey, and in sphenodon, and a general review of the literature on this subject with reference to other types of vertebrate animals, Dandy, in 1899, came to the important conclusion that the ancestors of vertebrates must have possessed a pair of parietal eyes which may have been serially homologous with the ordinary or lateral eyes. The general conception of its morphology at this period was that the pineal system reached its maximum of development in certain extinct reptiles, and that among living forms it is more highly developed in those of a primitive type such as sphenodon, than in higher classes of vertebrates: in other words, in higher types of vertebrates it persisted merely as a vestigial and useless structure. Tilney and Warren have, however, adduced reasons for regarding the pineal organ of higher vertebrates as an evolving structure, and that neither from evidence based upon its gross morphological characters, nor on its histological structure, is it a mere vestige. They consider the pineal body (epiphysis, parapineal body) to be an endocrine organ, having a definite function. Further, they believe that there is no direct relation between the pineal eye and the pineal body, but that each is an adaptive modification toward the development on the one hand of a pineal eye, and on the other of a glandular organ.

The main or glandular parts of the pineal body in the adult human subject represents the epiphysis or parapineal organ of the reptilian pineal system. Closely associated with this part there is present also in the post-embryonic and fœtal stages of development a tubular outgrowth from the caudal end of the roof of the third ventricle. This is applied to the dorsal aspect of the epiphysis, and lies below the splenium of the corpus callosum. It probably represents a part of the 'postvelar or dorsal sac' of reptiles, and possibly also the blind caudal end of the 'paraphysis', which in sphenodon and other lizards interveries between the dorsal sac and the epiphysis. The 'paraphysis' resembles in microscopic structure the choroid plexus, but differs from the choroid plexus of the third ventricle (diencephalia plexus) in being an evagination from the roof of the ventricle instead of an invagination, and in the presence of secondary lobular evaginations. In the adult the communication with the third ventricle is usually obliterated, and its mouth is represented merely by the suprapineal recess. The fundus and intermediate part of the tubular outgrowth tend to disappear, but remnants of it may persist in the adult and give rise to one type of pineal cyst. Cysts containing choroidal villi may also occasionally be found included in tumours of the pineal gland.

What the exact function of the pineal gland is, is by no means certain. In those animals in which it is most highly developed it shows a definite glandular structure; cells containing what appear to be secretory granules are in close relation with thin-walled capillary vessels, and the structure of the organ thus resembles in many respects that of endocrine glands in other parts of the body, e.g., the pituitary and suprarenal bodies.

The evidence of its action on metabolism is, however, very contradictory. It has been thought that the pineal gland secretes a hormone which is concerned with the development

of the skeletal and sexual systems. Young boys in whom a pineal tumour has been found to be present have shown precocious sexual development. After the sixth or seventh year the gland normally undergoes an involutionary process, and after middle life usually shows degenerative changes associated with calcareous deposit both in the gland itself and in the surrounding membranes. The degeneration affects chiefly the 'glandular' or parenchymatous cells, which tend to be replaced by fibrous supporting tissue. There is also a tendency towards the formation of cysts and degenerative changes in the walls of the vessels.

DEVELOPMENT OF THE PINEAL ORGANS IN MAN

In the human subject the pineal body is developed as a diverticulum from the posterior part of the roof of the third ventricle. It appears first when the embryo is from 12 to 15 mm. in length, that is, about the seventh week of fœtal life. At the 20-mm. stage a secondary diverticulum makes its appearance. It lies in front of the primary bud and appears to have grown forwards from the anterior wall of the original hollow outgrowth. Both the original outgrowth and the secondary diverticulum are lined by ependyma, which is in relation externally with a stratum of irregularly disposed cells. These cells are so disposed as to show a tendency towards the formation of lobules. The thickness of the wall varies in different situations. The ependymal cells have oval nuclei, which stain deeply with hæmatoxylin, and are arranged radially around the lumen. Some of the nuclei of the cells next the lumen show mitotic figures, and the layer may be regarded as a proliferating zone from which the newly-formed cells pass outward into the mantle zone. The cells of the intermediate or mantle zone are less deeply stained than those of the ependyma, and tend to assume a more spherical outline. At a later stage they differentiate into parenchymal or glandular cells and supporting or glial cells. Externally is a thin reticular or marginal zone in relation with the outer covering of pia mater, in which a plexus of thin-walled capillary vessels is a conspicuous feature.

If the pineal region is examined at a considerably later stage, e.g., in a 6-cm. human embryo, it will be found that the pineal organ (epiphysis) has increased considerably in size. Its lumen still communicates with the cavity of the third ventricle, where it opens between the habenular commissure in front, and the posterior commissure behind. The apex of the diverticulum projects backward below the inferior sagittal sinus and falx cerebri, and above the quadrigeminal plate of the mid-brain. It lies between the right and left layers of pia mater, which are attached above to the lower border of the falx cerebri, and pass downwards on each side of the brain stem to gain an attachment to the upper surface of the tentorium cerebelli near its free border. These layers are quite distinct from the pia mater investing the hemispheres. Covering the pineal body, and reflected backward over the dorsal aspect and sides of the midbrain, is a layer of pia mater which blends with the right and left layers on the dorso-lateral aspect of the brain-stem. Consequently in transverse section the pineal gland appears to be enclosed in a triangular space, having its apex at the lower border of the falx cerebri, in which the inferior sagittal sinus is enclosed. Within this space are numerous thin-walled vessels lying in a loose mesenchymatous tissue: these are continuous with the choroidal vessels forming the vascular supply of the pineal gland.

Returning to the description of the pineal body itself, there is found at this stage an almost solid mass of cells lying in front of the main body and above the habenular commissure. This is the anterior lobe, and it is continuous at its base with the chief part of the gland. The lower and posterior wall of the main outgrowth shows a temporary secondary diverticulum, which lies between the main part of the posterior commissure and a smaller fascicle of commissural fibres, which itself lies above the secondary pocket, between it and the primary outgrowth. This has been described as the infrapineal recess, but it is not present in the adult. The original stalk and the temporary recess apparently open out into the cavity of the third ventricle. The original stalk of the developing pineal body thus disappears, and the pineal recess of the adult is the remnant of the basal part of the central cavity after this has become closed and separated off from the ventricle. The wall of the apical part of the epiphysis and the anterior lobe is definitely lobulated at this stage, outgrowing finger-shaped processes of the epithelial diverticulum interdigitating with vascular ingrowths from the surrounding pia-arachnoid.

Anterior to the pineal diverticulum at this stage there are to be found two or more evaginations of the roof of the third ventricle. The apices of these outgrowths are directed backward, and the more posterior overlap the base of the anterior lobe of the pineal body. They may possess a common stalk, and bifurcate near the apex into right and left lobules, or arise as definitely bilateral outgrowths. At a later phase of development, a tubular diverticulum of the ependymal roof of the third ventricle extends backwards over the dorsal aspect of the epiphysis as far as or beyond its apex. The diverticulum is lined by choroidal epithelium, which in places forms tufted ingrowths of choroidal villi which will contribute to the secretion of the cerebrospinal fluid as long as the mouth of the sac remains open. Usually, however, the stalk becomes closed near its mouth, leaving a closed sac which may become obliterated, or persist and give rise to one or more cysts lined by choroidal epithelium. The mouth of the stalk persists as the suprapineal recess, which lies immediately above the habenular commissure. The outgrowths are of considerable interest from the standpoint of comparative anatomy, as they probably represent the 'dorsal sac' and 'paraphysis' of lower vertebrates.

FUNCTION OF THE GLAND

In order to determine the significance of the pineal gland, physiologists and others have tried the effect of feeding animals and human beings with pineal substance. In animals the experimental findings have not been consistent. Some observers working with young guinea-pigs, kittens, and rabbits, have recorded a gain in weight compared with controls, while other investigators have not found this to be the case. All observers, however, find that pineal feeding is completely without effect after maturity is reached.

The results of investigating the effect of feeding children on pineal substance are not reliable owing to the difficulty in obtaining controls.

The experimental removal or destruction of the pineal gland in animals has been performed by Dandy, in America, without any noticeable after-effect upon the well-being of the animal, and has resulted in no apparent mental or physical change.

SYMPTOMATOLOGY OF PINEAL TUMOURS

Enlargements of the pineal gland usually present clinically a well-defined syndrome. Owing to the anatomical position, enlargements of the gland cause pressure on structures which give rise to clear-cut clinical symptoms and hence are quite early recognizable.

The symptoms can best be considered under three headings: (1) Focal—those due to the lesion itself. (2) Local—the changes brought about within the central nervous system. (3) General—the somatic changes which sometimes accompany such enlargements.

1. Focal Signs.—The focal signs which may be produced by tumours are due in the main to the anatomical position of the gland (*see Fig.* 392). It is because of its relationship to the superior corpora quadrigemina that the eye signs produced are so characteristic.

The aqueduct of Sylvius lying below the gland is very liable to be occluded and produce a severe degree of internal hydrocephalus when pressed upon by a pineal tumour.

The cerebellum lies immediately posterior to the pineal and is often invaded by growths arising in that neighbourhood.

A contributory factor in the production of the internal hydrocephalus is the fact that the vein draining the choroid plexuses—the vein of Galen—is very liable to be compressed, with the result that engorgement of the choroid plexuses is produced and possibly an increased secretion of the cerebrospinal fluid.

Tumours which arise in the pineal may extend in various directions, and *Fig.* 393 illustrates the common methods of extension.

Eye Signs.—Tumours may extend into the corpora quadrigemina and produce a clinical syndrome which is characterized by loss of pupillary reaction, reaction

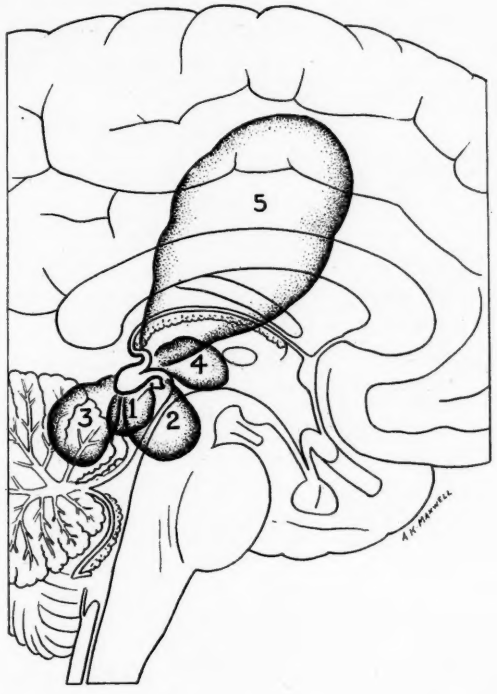

FIG. 393.—Schematic representation of the various ways in which a pineal tumour may extend and cause pressure symptoms: (1) On the corpora quadrigemina; (2) On the aqueduct of Sylvius; (3) Downwards on the cerebellum, causing cerebellar symptoms; (4) On the midbrain; and (5) On the cerebral hemisphere.

to accommodation upward, downward, and lateral movement, in that order of development. It is extremely common to find that the light reflex is absent and the patient unable to look upward.

To understand this clearly it is necessary to visualize the arrangement of the oculomotor nuclei (*Fig.* 394). It will be remembered that the nuclei of the IIIrd, IVth, and VIth nerves lie in about one continuous line on either side of the aqueduct just below the corpora quadrigemina, together with the medially placed nuclei. Various functions have been mapped out for the several parts of the nucleus. In *Fig.* 394 it will be seen that the Edinger-Westphal nucleus (A) is the most anterior, and is concerned with control of the pupillary and ciliary muscles; the dorsilateral nucleus (B) is concerned with upward movements; the

ventromedial nucleus (C) is concerned with downward movement; the central nucleus with movements of divergence. The small caudal nucleus (D) may be concerned again with pupillary reaction.

Thus it will be seen that pressure exerted from in front and above the nuclei will give rise first to absence of light reflex, then to loss of accommodation and loss of upward and downward movement. In clinical practice it is the lateral movements which persist for the longest period.

Ear Signs.—Should the inferior corpora quadrigemina be pressed upon, then deafness, unilateral or bilateral, complete or partial, may result.

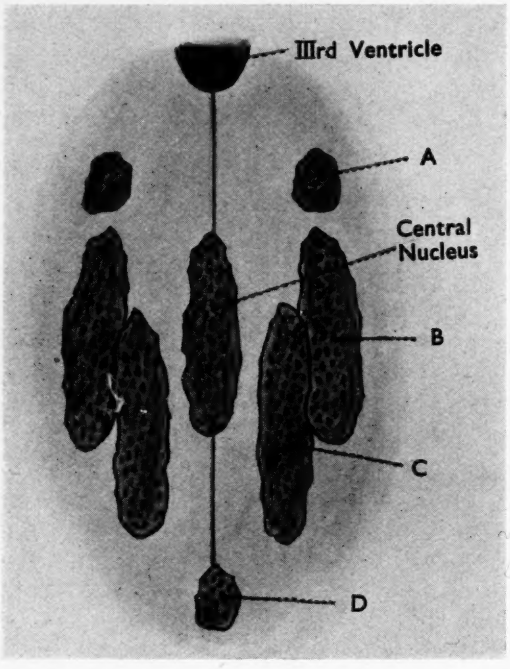

FIG. 394.—Diagram showing arrangement of oculomotor nuclei.

Cerebellar Signs.—Extension occurs into the cerebellum. This may be into either hemisphere or directly in the midline.

Nystagmus is very common; there is often giddiness and inco-ordination with a tendency to swerve to the side most affected, or, if in the midline, a tendency to fall backward. There is weakness, adiadochokinesia, intention tremor in the arms, and usually a grossly ataxic gait. Rombergism may be present. The cerebellar involvement will in some cases also give rise to a dysarthric speech, usually staccato in type.

Other cerebellar signs may be present. On extension of the hands there is a tendency to fall away on the side of the lesion. The past-pointing test may show deviation.

The reflexes may be diminished or absent on one or both sides and the limbs atonic, but usually the pyramidal involvement predominates.

Pyramidal and Sensory Signs.—The pyramidal tracts and medial lemnisci may be affected. Involvement of the pyramidal tracts gives rise to increase in tone on the affected side, weakness, increased deep reflexes, absent abdominal reflexes, and an extensor plantar response. The sensory changes take the form of a hemianæsthesia, as all the sensory fibres at the level of the corpora quadrigemina have joined the medial lemniscus.

Signs of Third Ventricle Involvement.—The somatic changes sometimes associated with pineal tumours have been referred to involvement of the hypothalamus and third ventricle.

Disturbed temperature regulation has been reported in a few cases of pineal tumour. The hypothalamus is probably concerned in the control of body temperature, and the case reports show that there may be rise of temperature of an irregular type without any apparent source of infection and with no corresponding rise in pulse-rate. The controlling centre in the hypothalamus itself or its efferent pathway may be damaged. Polyphagia, polyuria, and glycosuria have also been observed and are probably due to hypothalamus involvement.

Signs of Involvement of the Cerebral Hemispheres.—As a pineal tumour grows, extension occurs upwards into the hemispheres. It is of necessity a deep extension and the motor cortex and sensory cortex are not usually involved. The optic radiations, however, pass nearby on their way to the occipital cortex, and these may be cut through and a right or left homonymous hemianopia result.

2. Local Signs.—Owing to the site of the lesion, signs due to raised intracranial pressure manifest themselves early in the course of the tumour growth. Headaches are severe and continuous and are associated with vomiting. Mental lethargy and reduction in mentality may be early signs, as may also giddiness. Loss of vision occurs from the effects of papillœdema, which is usually very marked and presents itself as a very early sign. Epileptiform fits also occur.

Signs are produced in the cranial nerves as the result of the raised intracranial pressure. The third ventricle is commonly affected, and double vision and strabismus are frequently seen. The VIth nerve is also involved. There is paralysis of the external rectus on either or both sides, with a convergent strabismus. The olfactory nerve is not affected. The Vth nerve may be affected, giving rise to a weakness and sometimes sensory loss on that side of the face.

Facial paralysis is seen quite commonly, and is either produced by the local extension of the growth or from damage to the nerve resulting from the raised intracranial pressure.

Deafness is common, and has already been mentioned.

The nerves IX, X, XI, and XII are not usually affected: only if the cerebellum is extensively invaded will they be pressed upon and give rise to their characteristic physical signs.

3. General Signs.—Pineal tumours associated with general somatic changes are almost confined to the male sex. The disturbances of growth associated with pineal tumours affect chiefly the genital organs, but are often associated with adiposity and sometimes with general and symmetrical overgrowth.

Hypertrophy of the penis and testes, with growth of pubic hair and precocious sexual instinct, have been observed with most tumours classed as teratomata, as well as with simple, benign, and malignant tumours. The testicles show a marked increase in the size and number of the interstitial cells. The breasts enlarge, and

one case has been reported of a secretion of colostrum in a boy aged 4, associated with testicular enlargement.

Increase of hair occurs also on the lips and chin and in the axillæ. Deepening of the voice may take place.

The adiposity which occurs has been observed with all varieties of pineal tumours, and cannot be distinguished clinically from hypophyseal obesity—probably because, as already pointed out, it is in both cases due to hypothalamic involvement. The adiposity is proximal in distribution; it is marked over the shoulders and pelvic girdles, with considerable enlargement of the breasts. The buttocks, thighs, and abdomen also show heavy deposits of fat.

Physiological experiments seem to point to the fact that injection of pineal extracts in chicks and guinea-pigs shows a general increase in size, with genital overgrowth and sexual precocity, but the evidence is still not completely convincing.

The possibility is that the pineal gland normally facilitates growth in general, and sexual development in particular. Acceleration of these functions occurring in the course of pineal tumours may therefore be interpreted as hyperpinealism. In the absence of further data, obesity and hypertrichosis may be considered as part of the general and sexual overgrowth, but the hypophyseal failure must be considered as a possible contributing factor in the adiposity.

A close relationship evidently exists between the pineal and testicular functions which is probably not antagonistic in nature, but as yet there are insufficient data to define the relationship between the pineal and the other ductless glands, and hence its relationship to the gonads. However, in quite a number of cases there are no signs whatever of any sexual abnormality.

PATHOLOGY OF PINEAL TUMOURS

The various pathological conditions which arise in and around the pineal gland can be discussed in relation to the actual lesion itself, in relation to the local changes produced inside the cranium, and in relation to the somewhat variable general skeletal and endocrine changes which are sometimes associated with such pathological conditions.

General Pathology.—The pineal gland may undergo simple hypertrophy. This was described by Virchow as occurring in an infant. It has also been observed in association with other pathological conditions, such as myxœdema and polyglandular dysfunctions, and has also been described in a case of general cerebral hypertrophy.

Laignel has observed and described a case in which atrophy of the gland was found.

The other pathological conditions arising in and in the region of the pineal may be classified as follows: (1) Cysts; (2) Cholesteatomata; (3) Teratomata; (4) Pinealomata; (5) Pineoblastomata.

1. *Cysts.*—Cysts of various types have been described in relation to the pineal. They are usually simple cysts without any associated tumour growth. Often they may be found to project into and obliterate the third ventricle and to compress the corpora quadrigemina. They almost invariably give rise to hydrocephalus by blockage of the aqueduct.

No rule can be formulated as to the age incidence of such growths, since they have been described both in the newborn and in the aged. Such cysts are commonly single, but may be multiple. They are lined with flattened cells and contain fluid which is occasionally discoloured from recent hæmorrhage. These cysts are very seldom accompanied by any changes of the pubertas præcox type.

2. *Cholesteatomata.*—These tumours occur in the region of the pineal; they are firm in consistency, the cut surface being yellowish-white and waxy in appearance. On section they can be seen to be composed of lamellated waxes or scaly material enclosed in a wall of stratified squamous cells concentrically arranged. Such cells may be multinucleated. The waxy material consists of desquamated cells and cholesterol crystals.

Cholesteatomata occur anywhere in the brain, but more especially do they occur near the midline. They are regularly connected with the meninges. Bostroem concludes that all cholesteatomata arise from embryonal epidermal inclusions.

3. *Teratomata.*—These tumours arise exclusively in young males from 4 to 16 years of age, and are associated with precocious sexual development, hirsuties, and sometimes with adiposity and general overgrowth.

These complex teratomata are of moderate size; they may be solid or cystic, and are usually circumscribed. They give rise to marked pressure signs. They may consist almost entirely of hair, sebaceous material, epidermoid cysts, cartilage, calcific grains, fat tissue, and non-medullated nerve-fibres and smooth muscle. A small layer of normal pineal tissue may be found beside, and usually compressed and displaced by, the tumour. They are firm in consistency, irregular and knobbly on the surface, often with elongated shreds of tela choroidea adherent to the upper and posterior surface.

Their nature and origin is obscure, but of interest; they are probably derived from embryonic vestiges. The dermal structures, such as hair and sebaceous glands, require an ectodermal tissue for their development, which may possibly reach the pineal gland by the same developmental disturbances that give rise to cholesteatomata. It must also be remembered that in certain reptiles and fishes the pineal is a well developed organ which in the selachians passes through a minute foramen in the skull and reaches the surface. Alternatively these may develop by pseudogestation from a fertilized filial polar body.

4, 5. *Pinealomata and Pineoblastomata.*—Tumours arising from the pineal gland tend to resemble the structure of the developing pineal at some definite stage of its development. The more primitive the type that is found in these tumours, the more rapidly growing and more invasive is the growth. The primitive type of such tumours is termed pineoblastoma. The course is usually short. If the tumour cells resemble more the adult type of pineal structure, they are slow growing, less invasive, are less liable to hæmorrhage and less vascular, and the tumour is termed pinealoma.

Pineoblastomata: These tumours are usually soft, with a tendency to infiltrate into the surrounding tissue—the hemispheres, the cerebellum, and the third ventricle—and tend to obliterate the aqueduct. Cysts are often present, and areas of hæmorrhage occur. The surface is irregular and lobulated; cysts may be seen on the cut surface.

Microscopically there is a marked variation in the type and arrangement of cell found. The cells are arranged in a mosaic with streams of small cells deeply

staining in character and enclosing nests of larger cells with vesicular nuclei and larger masses of clear cytoplasm, bearing a strong resemblance to the parenchyma cells of the mature pineal body. Giant cells are not an uncommon feature in various areas of these tumours; they are more common in the vicinity of the calcified plaques which are a frequent feature of such growths.

Pinealomata: The other main type is that which more closely approximates to the adult or mature type of pineal. They are slower in growth and less invasive. Hæmorrhages and cysts are less common. Microscopical section shows an alveolar pattern; the cells are chiefly of the large vesicular type, and are separated by strands of fibrous tissue.

Thus we see the importance of recognizing the developmental stages through which the pineal passes when attempting to understand the histology of these tumours.

General Changes.—The associated changes in the brain are due to direct displacement and invasion of the brain substance. The cerebellum is often invaded. The growth extends beneath the tentorium and invades the cerebellum both in the midline and in either of the lateral lobes.

The midbrain is pressed upon, and especially the corpora quadrigemina. This distortion gives rise to the characteristic eye signs and may also occlude the aqueduct of Sylvius. Occlusion of the aqueduct may also be brought about by direct invasion of the third ventricle by the growth. The outcome of these changes is that the whole ventricular system above the aqueduct becomes distended, and internal hydrocephalus results. Pressure on the vein of Galen by the growth may also play a part in the development of the hydrocephalus.

The floor of the third ventricle is depressed. The hypophysis is pressed upon and the hypothalamus distorted. It is this change as well as the direct invasion which occurs which probably accounts for the changes in growth and sexual development and other hypothalamic signs which are sometimes seen. Extension may occur into the cerebral hemispheres by direct invasion.

Hæmorrhage occurs into these growths, and terminally hæmorrhage into the ventricles is not an uncommon finding. Changes are also found around the medulla, there usually being a very well-developed pressure cone.

OPERATIVE TECHNIQUE

Although it is possible to operate on the pineal using local infiltration of the scalp and some scopolamine and morphine, yet it is preferable in the author's opinion to use rectal avertin, local infiltration of the scalp with ½ per cent novocain, and to follow with intratracheal gas and oxygen. The reasons for using intratracheal gas and oxygen are that it is desirable to have the patient completely quiet while the deep approach to the pineal is proceeded with, and that if the patient stops breathing, oxygen or carbon-dioxide can be given, a very desirable precaution when operating near the brain-stem, where slight deflections in either direction may press or drag upon the respiratory centre.

There are only two approaches to the pineal gland which are of any practical value, and both demand a large right occipito-parietal osteoplastic flap.

1. *Dandy's Operation.*—This is the method of choice, and is based on experimental operative procedure performed on dogs. After preliminary infiltration of

the scalp with novocain, a large occipito-parietal scalp flap is fashioned (*Fig.* 395) and bleeding controlled. Some five burr holes are made in the skull at the periphery of the scalp incision, and these burr holes are joined by means of a Gigli

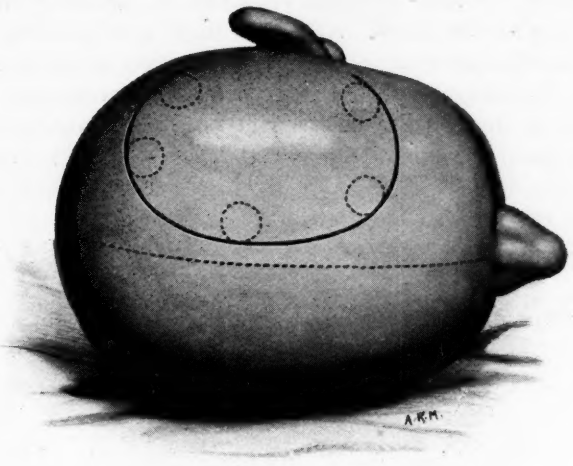

FIG. 395.—Drawing showing skin incision and site for the burr holes in the bone so as to expose the posterior two-thirds of the cerebral hemisphere.

saw, which is inserted by a special curved introducer (*Fig.* 396). After the saw has been introduced, the bone between the burr holes is cut on the bevel, the introducer acting as a protector to the underlying dura mater and brain (*Fig.* 397).

FIG. 396.—Useful Gigli saw guide.

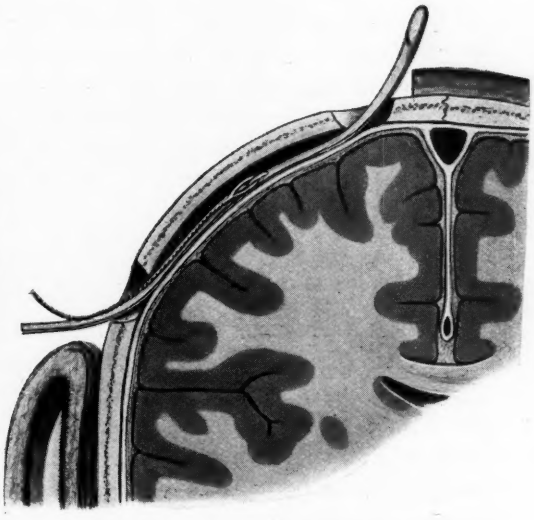

FIG. 397.—The method of introducing a Gigli saw between two burr holes.

When all the burr holes have been united with the exception of the lowest two, the osteoplastic flap can be elevated and fractured across its narrow and thinned-out base; it is then hinged outwards on the temporal muscle. Bleeding vessels in the dura mater are underrun with silk sutures, while those occurring in the bone are

controlled with Horsley's bone wax. If there is a considerable increase of the intracranial pressure this can be diminished by the administration of 20 c.c. of hypertonic saline (15 per cent) at the commencement of the operation, but as a rule this is not necessary because adequate reduction of the intracranial pressure may be produced by tapping the lateral ventricle. It is a remarkable fact that although an internal hydrocephalus causes gradual destruction of cerebral tissue, yet this hydrocephalus is advantageous to the surgeon when removing a pineal tumour; otherwise it would be impossible to retract the posterior part of a normal hemisphere without causing some permanent damage. When the fluid from the ventricle is withdrawn in a case of internal hydrocephalus, the flattened-out hemisphere can be retracted without further damage ensuing.

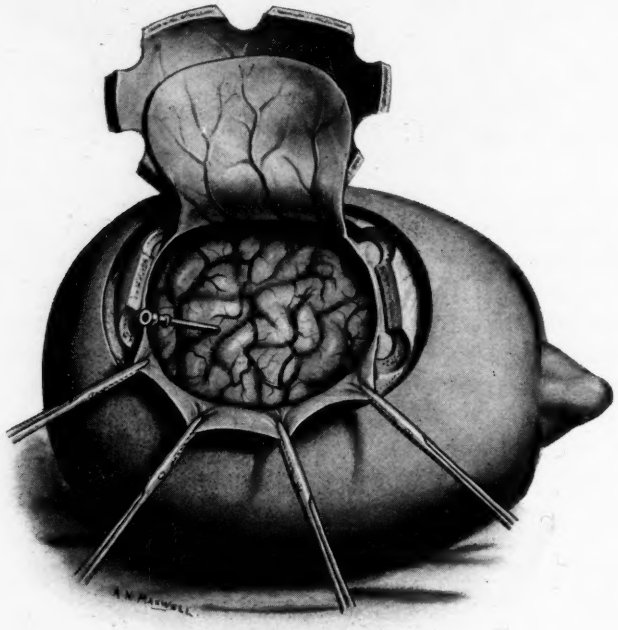

FIG. 398.—The method in which the osteoplastic flap is raised and turned outwards: flap of dura mater is then turned outwards and the lateral ventricle tapped.

A flap of dura mater is turned outwards on top of the osteoplastic flap (*Fig.* 398) and bleeding from the cut surface of the dura is controlled with silver clips. As the mesial margin of the flap extends almost to the superior sagittal sinus, there are numerous bleeding vessels which will require ligature; some of the smaller ones may be dealt with by silver clips. The lateral ventricle is then tapped at the junction of its body and descending horn, the cerebrospinal fluid being allowed to flow away over the brain; the needle is left in situ for as long as possible to ensure complete evacuation of the ventricle.

The next step is to divide any cerebral veins which may be running from the upper part of the hemisphere into the superior sagittal sinus. There are five or six of these veins, and they can be secured between fine ligatures or silver clips. Care should be taken to avoid injury to the vein which drains the Rolandic area of the brain, otherwise a transient hemiplegia may result.

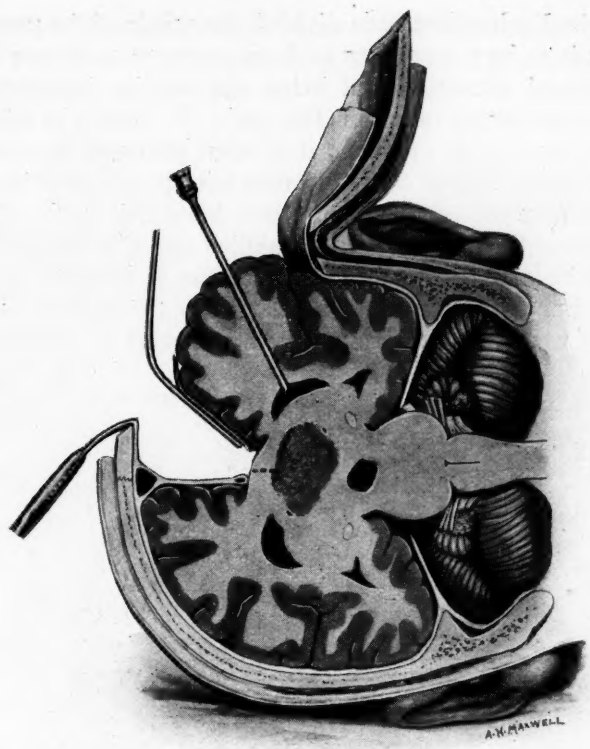

FIG. 399.—The posterior part of the cerebral hemisphere is retracted so as to expose the corpus callosum.

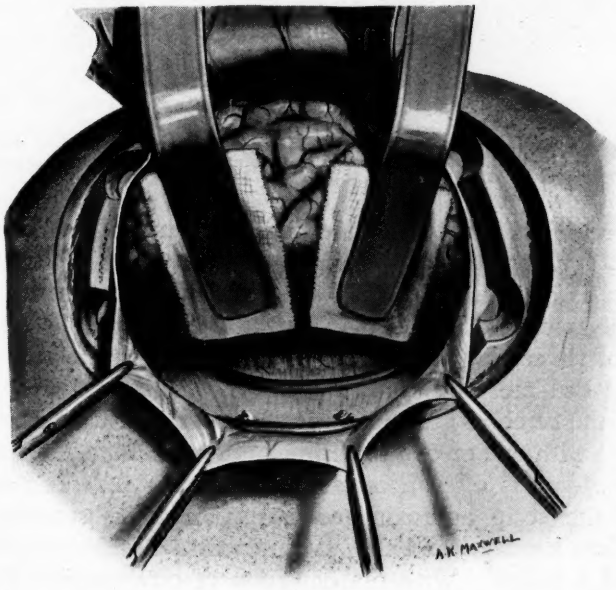

FIG. 400.—The exposure of the corpus callosum. The ligatured cerebral veins can be seen as they enter the superior sagittal sinus.

After the cerebral veins have been divided, the whole of the posterior extremity of the hemisphere is to be retracted to such an extent as to expose the falx cerebri (*Fig.* 399). Continued retraction will bring the inferior longitudinal sinus into view, and beneath it the corpus callosum (*Fig.* 400). To obtain an adequate exposure of the splenium of the corpus callosum, it is often advisable to divide the inferior longitudinal sinus between silver clips, and then slit up the lower border of the falx for half an inch or more with a curved tenotomy knife (*Fig.* 401). The splenium of the corpus callosum is then incised in the midline and the tumour exposed. Any bleeding that may be encountered in this procedure is checked by the diathermy point. The most important structure in relation to the tumour is the great vein of Galen, which lies under the fornix. This vein and its tributaries should be

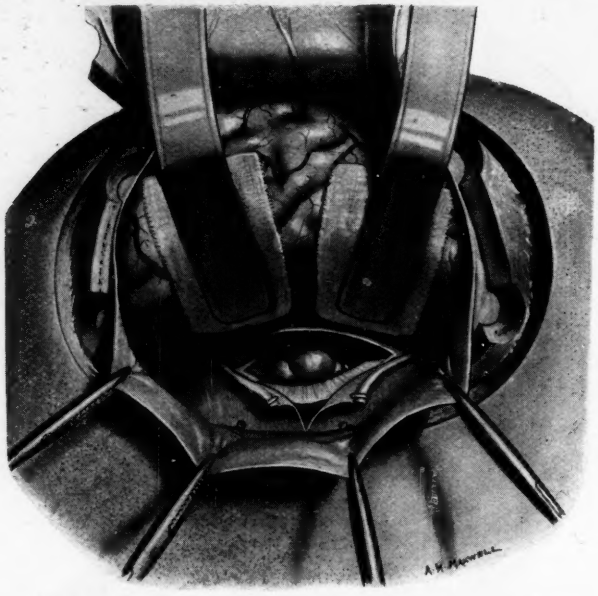

FIG. 401.—The inferior surface of the falx has been divided, together with the inferior sagittal sinus. The posterior end of the corpus callosum has been divided, exposing the pineal tumour.

carefully preserved. The tumour is carefully prised out of its bed by means of a curved dissector, such as Adson's. It may be that the third ventricle is opened while the tumour is dissected out of its bed, but this does not matter (*Figs.* 402, 403). Absolute hæmostasis is essential, and all bleeding points are controlled by the application of silver clips or the use of the diathermy point.

The tumour bed must be quite dry before completing the operation. The posterior part of the cerebral hemisphere is allowed to fall back into place, and the dura mater united with one or two tethering sutures. Drainage by means of a fine corrugated rubber dam is often necessary for a day or so. The osteoplastic flap is replaced and the scalp approximated by two layers of sutures. The head is covered with a firm bandage, and the patient nursed flat for the first three days and then allowed a pillow. With the depletion of cerebrospinal fluid during the operation, it is necessary to balance this by an adequate intake, and therefore after the operation a continuous rectal saline infusion is instituted. A purge is given on

the second day after operation, and if there is much headache a lumbar puncture is performed. The stitches are removed on the tenth day, and the patient is subsequently allowed to get out of bed.

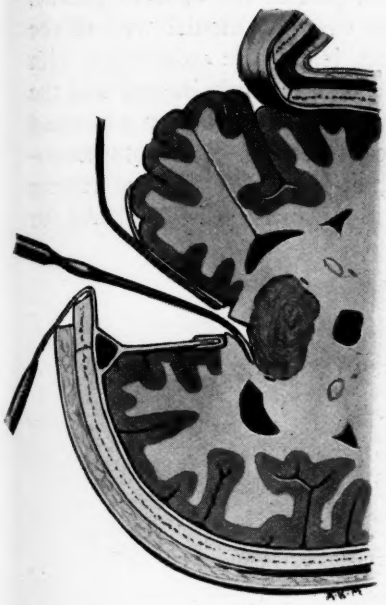

FIG. 402.—Section through the brain showing the exposure and incision of the corpus callosum.

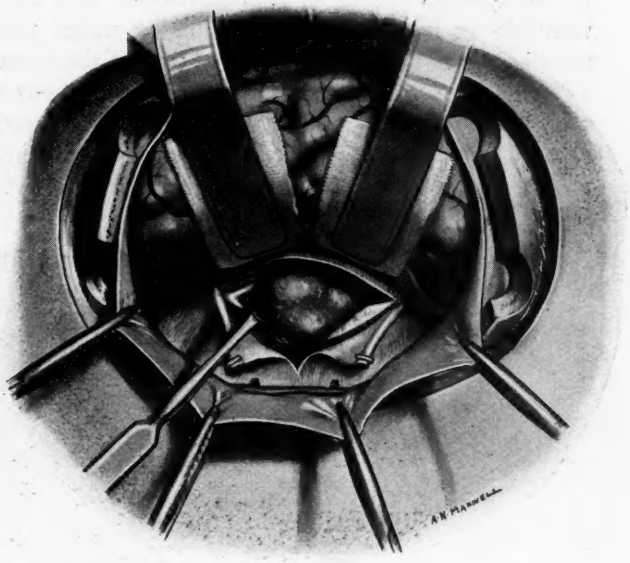

FIG. 403.—The actual removal of a pineal tumour.

2. *Van Wagenen's Operation.*—The second method of surgical approach is that devised by van Wagenen, in which the tumour is attacked through the median wall of the lateral ventricle. It is an easier method and the route is less vascular, and the tributaries of the great vein of Galen can be more easily seen and dealt with. The disadvantage, however, is that it leaves some permanent disturbance of function in the form of hemiplegia and homonymous hemianopia.

The first part of the operation is very similar to Dandy's approach—an osteoplastic flap is fashioned and turned outwards (*Fig.* 404). The dura mater is incised and a flap turned downwards. A reversed L-shaped incision, about 6 cm. in length, is made in the cortex, extending from the posterior end of the superior temporal lobe gyrus upward and slightly backward, ending in the lobus parietalis superioris. This incision is gradually deepened by means of the diathermy cautery, using the cutting and coagulating

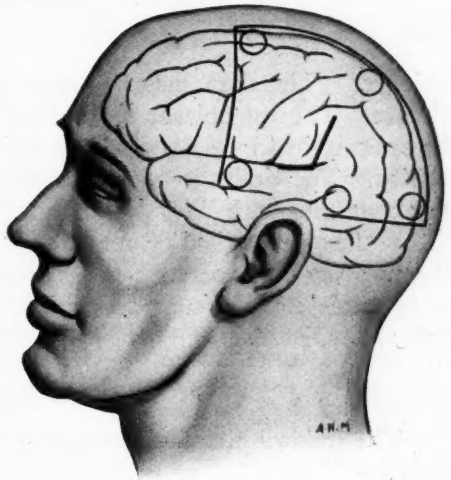

FIG. 404.—Van Wagenen's approach to the pineal, showing the outline of the osteoplastic flap and the site of the incision in the cortex.

currents alternately, and its edges retracted by small flange retractors covered with moist lint. The incision is deepened until the dilated lateral ventricle is opened (*Fig.* 405). The wound can now be retracted sufficiently to enable the surgeon to see the bulging medial wall of the ventricle covered in part by the choroid plexus. If the choroid plexus is well developed and extends over the medial wall of the ventricle in the region of the bulging pineal tumour, it may be coagulated with the diathermy point. The medial wall of the ventricle is then gently incised and the pineal tumour exposed and gradually separated from its connections (*Fig.* 406). Absolute hæmostasis is procured, and a small piece of rubber dam is inserted into the incision in the brain for

FIG. 405.—Sectional view of the approach to a pineal tumour through a dilated lateral ventricle.

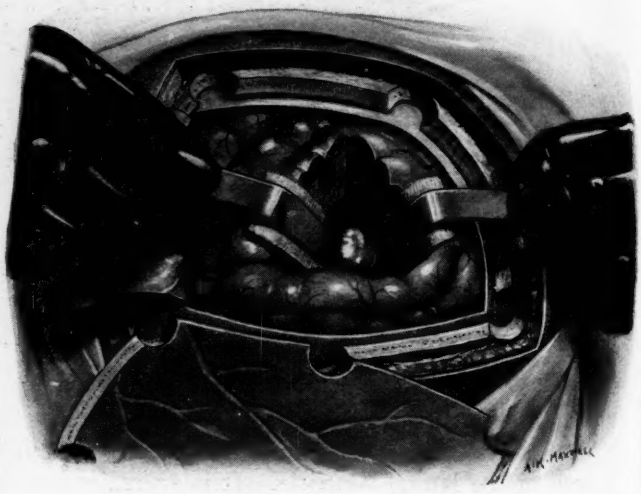

FIG. 406.—Actual exposure of a pineal tumour through the lateral ventricle.

drainage. The dura mater is replaced and held in position by a few anchoring stitches. The osteoplastic flap is accurately put back in its original position, and the scalp united by a double layer of interrupted sutures, and a firm dressing then applied. The drainage wick is removed after twenty-four hours and the stitches on about the tenth day.

Whichever method of operation is adopted, it is a wise precaution to give the patient some post-operative X-ray therapy, as it is impossible to be quite sure that every particle of the tumour has been removed, and pineal tumours for the most part are radiosensitive.

CASE REPORTS

The following clinical cases have come under observation and treatment since 1919 :—

Case 1.—Elsa B., aged 26, was admitted to hospital under the late Sir David Ferrier, in May, 1919, complaining of headache and vomiting. Up to a year prior to admission the

patient was a cheerful individual who was employed in a laundry, and was very keen on tennis. Gradually she lost interest in her work and gave up all games. For a month previous to her admission to hospital she had attacks of vomiting, and was unsteady while walking.

ON EXAMINATION.—The patient appeared rather depressed but was quite keen to co-operate in the hope that something could be done to relieve her symptoms. She walked with a staggering gait, but there did not seem to be any tendency to fall to either side. She had a good sense of smell. The visual fields were complete. Bilateral papillœdema was present, more marked on the right side—right, four diopters; left, three diopters. The pupils were dilated, and did not react to light and accommodation. There was loss of conjugate upward movement of the eyes. There was weakness of the right sixth nerve and bilateral nerve deafness. The other cranial nerves appeared normal. There was a fine lateral nystagmus to the right. Ataxia was marked, and Romberg's sign was positive. The diagnosis of a pontine or pineal tumour was made, and a subtentorial decompression advised.

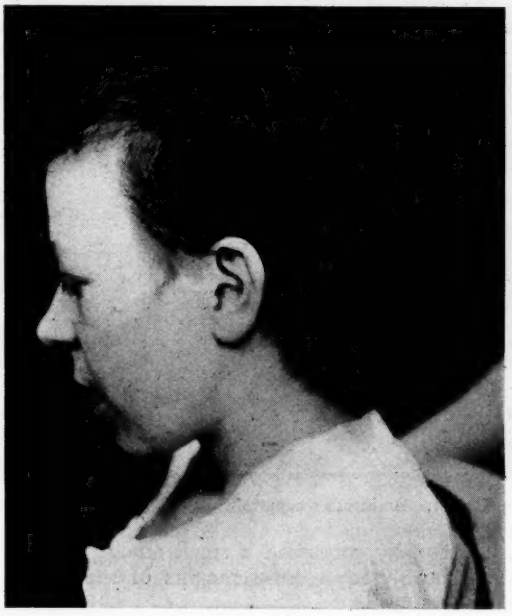

FIG. 407.—Photograph of *Case* 1, showing bulging through a sub-tentorial decompression.

OPERATION.—On May 15, 1919, a large subtentorial decompression was performed under ether anæsthesia; there was marked increase of the intracranial pressure, but no tumour was discovered. The wound was closed without drainage. Healing was sound and the stitches were removed after ten days. The patient rapidly improved after the operation, the vomiting stopped completely, and the papillœdema subsided. However, a month after the operation the decompression area began to bulge (*Fig.* 407), and the papillœdema returned. The patient began to go downhill and died two months after her operation.

An autopsy was performed and the brain removed entire and hardened. No obvious tumour could be seen. After the hardening process was complete, several sections were made through the entire brain, and a pineal tumour was discovered.

PATHOLOGY.—The tumour was situated between the splenium of the corpus callosum and the quadrigeminal plate of the midbrain, both these parts being invaded by an ingrowth of the tumour (*Fig.* 408). Its maximum transverse diameter in the section examined was 17 mm., and its vertical measurement 15 mm. There was no definite capsule, the growth being limited by the tissues with which it came into contact. Thus it was covered laterally by vascular pia mater, and where it was invading nerve-tissue this was pushed aside and

compressed, the original pial covering having been either partially or completely destroyed. The aqueductus cerebri had been flattened by pressure, its roof being almost in contact with the floor except in the centre, where in the position of the median groove in its floor the section showed a triangular space with the apex directed downwards. The single layer of cubical epithelium which lines the duct was retained on the right side, but had disappeared for the most part on the left side, where it was replaced by an ingrowth of vascular glial tissue. In the nerve-tissue of the splenium and quadrigeminal plate which surrounded the growth there was a considerable increase in the number and size of the blood-vessels. Many of these contained thrombi, in which there was a relatively very high proportion of lymphocytes as compared with red blood-corpuscles. The walls of the vessels were thickened, and there was a considerable nuclear proliferation in surrounding glial tissue.

The surface of the tumour was very irregular and in places lobulated. The central parts were broken down, an irregular cavity being present in the lower part of the section, with spaces running out from the main cavity into the central axes of the lobules, where the destruction of tissue was less complete. The central axes of the lobules showed a canal which was in some places lined by flattened epithelial cells, external to which was a layer of condensed glial tissue continuous with that of the tumour. These spaces were for the

FIG. 408.—*Case* 1. Brain after removal, showing position of pineal tumour.

most part empty, but occasionally contained a small amount of cell debris or degenerated blood-corpuscles. They probably represent remnants of the lumen of the original pineal outgrowth which had become cystic.

The tumour cells were loosely arranged in a lobular manner around these cystic spaces, the lobules being separated by vascular ingrowths from the surface. Two principal types of cell were present: the majority had spherical nuclei deeply stained with hæmatoxylin, and surrounded by a small amount of feebly-stained cytoplasm. Among these were larger cells with a feebly-stained round or oval nucleus. They appeared to belong to the supporting glial tissue, which in some places formed a trabecular network similar to that seen in the normal gland. No mitotic figures appeared to be present, though in some parts the cells were of small size and closely packed together, suggesting an active proliferation. In the upper part of the tumour there were extensive areas of necrosed tissue showing an irregular fibrinous network containing degenerated red blood-corpuscles and leucocytes, which were intersected by strands of degenerated glial tissue.

A small cyst lined by ependyma and containing choroidal villi was present at the base of one of the lobules in the lower part of the tumour. This was probably a remnant of the dorsal diverticulum which was present during fœtal life, and projects backwards over the pineal body from the posterior part of the roof of the third ventricle.

Case 2.—Harry P., aged 12, was admitted to hospital in Oct., 1923, with a history of constant headaches for nearly two years. He had been fitted with various glasses without any benefit. Four months before admission he had his tonsils and adenoids removed, as it was thought that this treatment might alleviate the headaches.

ON EXAMINATION.—The patient was thin, and inclined to be irritable. There was no sign of pubertas præcox. The pupils reacted sluggishly to light and accommodation, and there was bilateral papillœdema of 4·5 diopters in each eye. The visual fields were normal. There was complete paresis of upward gaze, and some weakness of the right sixth nerve. The hearing on the right side was somewhat diminished. The other cranial nerves were normal. There was a slight lateral nystagmus to the right. The gait was somewhat ataxic, and Romberg's sign was positive. There was very slight weakness of the right arm. All the deep reflexes were normal.

Radiographs revealed a calcified pineal body, and some opening up of the sutures of the skull. After the boy had been in hospital for a week attacks of vomiting and sweating commenced, and it was thought that the condition might possible be due to a tuberculoma. This diagnosis was supported by the fact that although the boy had a good appetite, he put on no weight, and remained exceedingly thin. However, owing to the very definite paresis of upward gaze, it was decided that the more probable diagnosis was that of pinealoma.

OPERATION.—Under rectal ether and local anæsthesia, a large osteoplastic flap was turned down over the right parieto-occipital region. The lateral ventricle was tapped, but owing to the poor condition of the patient no further exploration was carried out. The patient never really rallied, and died three days later.

At autopsy the pathologist unfortunately cut into the brain, and exposed a large but somewhat fragmentary vascular pineal tumour. Microscopically, there was a definite mosaic arrangement of the cells, with one or two giant cells surrounded by a definite layer of small cells. It was unfortunate that the brain was not hardened before it was sectioned.

Case 3.—Hilda H., aged 25, was admitted to hospital on Oct. 30, 1930, complaining of headaches, sickness, and occasional attacks of double vision. The headaches were not continuous, but occurred spasmodically, the patient being quite free from them for several weeks at a time. The headaches first commenced about two years previously. A month before admission to hospital she became unsteady in her gait, and could not see to mend her clothes. She was seen as an out-patient, and was found to have bilateral papillœdema, and admission was recommended.

ON EXAMINATION.—The patient was found to be well-nourished and quite cheerful, and very keen to get well in order that she could go back to her work.

There was bilateral papillœdema, four diopters of swelling in the right eye, and three diopters in the left. The pupils reacted sluggishly to light and accommodation. The visual fields were full. There was weakness of both sixth cranial nerves. There was limitation of upward gaze, which increased while under observation in hospital. An X-ray examination showed some increase in the meningeal grooves in the skull, which was significant of increased intracranial pressure. There was no sign of calcification of the pineal gland. There was some ataxia on walking, but this on the whole was slight. There was a fine lateral nystagmus to the right, and slight deafness in the right ear. Rombergism was present. The deep reflexes were slightly increased on the right side of the body. There were no other neurological symptoms. The diagnosis of tumour of the pineal gland was made, and a supratentorial approach was advised.

OPERATION.—On Nov. 21, 1930, under intratracheal gas and oxygen anæsthesia combined with local infiltration, a large occipito-parietal osteoplastic flap was turned down on the right side. The dura mater was very tense, and to relieve the intracranial pressure the right lateral ventricle was tapped. The dura mater was incised and the cerebral hemisphere was carefully retracted; several cerebral veins required to be secured by silver clips, as they entered the superior longitudinal sinus. On exposing the falx cerebri, a little more retraction brought the corpus callosum into view. Two silver clips were placed on the inferior longitudinal sinus, and the falx was divided between them. The corpus callosum was then divided longitudinally, and a large tumour of the pineal gland was exposed. An attempt to remove this with the diathermy knife failed owing to excessive bleeding from the great vein of Galen and its tributaries. When the bleeding was more or less under control the condition of the patient was so very poor that the osteoplastic flap was replaced, and the scalp wound closed. A blood transfusion of 400 c.c. of citrated blood was given immediately the patient returned to the ward. The condition of the patient rapidly improved, and next day she was talking quite happily. There was a well-marked lateral nystagmus to the left and right.

Thirty-six hours after the operation the patient became drowsy and then unconscious, with a pulse-rate of 50. The upper part of the scalp wound was opened and the bone flap removed, and the lateral ventricle tapped. Some 40 c.c. of cerebrospinal fluid were withdrawn. The patient rapidly improved after this, but by the tenth day after operation, when the stitches were removed, there was considerable bulging of the scalp in the region of the wound. Two hundred cubic centimetres of a 15 per cent sodium chloride solution were given intravenously. This worked like a charm, and the bulge completely disappeared for four days, when it became more tense again. As a further operation for the complete removal of the tumour was refused by the patient, it was decided to give a course of X-ray treatments. Four treatments were given at two-weekly intervals, the applications being given over the decompressed area. This kept the patient quite fit, the papillœdema subsided, and the patient was able to go home.

ON RE-ADMISSION.—She was re-admitted in May, 1931, with bulging of the decompression area and an increase in the papillœdema (*Fig.* 409). Operation was again refused

FIG. 409.—*Case* 3. Showing bulging of decompression area in the right occipito-parietal region.

and a further course of X-ray treatments was given. The patient was discharged in June, 1931, in an improved condition; the papillœdema was subsiding again and the cerebral hernia was less. She died quite suddenly in August, 1931, but no autopsy was obtainable.

Case 4.—Albert P., aged 23, was admitted to hospital under the care of Dr. Worster-Drought, on Oct. 9, 1931, complaining of headaches, drowsiness, dizziness, and a constant 'vacant' feeling. He was quite well until three months ago, when he first complained of occipital headache, which had persisted ever since. Soon after the headaches began he became drowsy and had attacks of 'vacancy', during which he would sit or stand motionless for as long as half-an-hour. He slept well and ate well. Apart from headaches he did not feel ill. He had noticed dimness of vision on occasions. He had had several attacks of giddiness, in one of which he fell downstairs. He had only vomited once prior to admission. He had grown fatter during the last three months.

ON EXAMINATION.—The patient was found to be somewhat slow in his movements. He weighed 12 st. 1 lb. A considerable amount of subcutaneous fat was noticeable (*Fig.* 410).

Cranial Nerves.—The pupils were equal, but reaction to light and accommodation was slow. The visual fields were normal to rough tests. Bilateral papillœdema was present; five diopters in the right and four in the left. There was no nystagmus, and the ocular muscles were normal. Speech was slow and ponderous, and the whole attitude was slow and heavy; he never smiled, and the facial expression seemed lost.

Sensation to cotton-wool and pin-pricks was quite normal. The cold tube felt hot on the right side of the trunk from the acromion process to the midline nearly down to the umbilicus. All limb reflexes were normal. The gait was slow, but with no obvious defect. Co-ordination finger-nose test was poor. Rombergism was slight. The heart, lungs, etc., were normal, and the blood-pressure 100/85. An X-ray examination made on October 16, 1931, showed that the sella turcica was enlarged and eroded, and the pineal body calcified. Cushing's thermic reaction was negative. The blood-sugar curve was normal. The visual fields were constricted. The cerebrospinal fluid showed: total protein 0·03 per cent; globulin, no excess. The Wassermann reaction was negative.

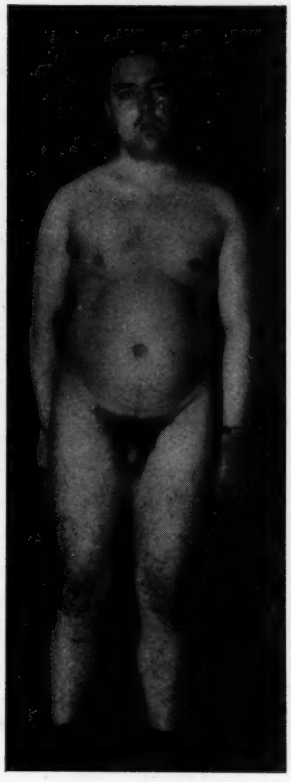

FIG. 410.—*Case* 4. Photograph of patient suffering from a pineal tumour. The vacant expression in this patient is well marked.

FIRST OPERATION.—Air ventriculography was carried out on Oct. 31, 1931, under local anæsthesia. A small trephine was made in the right parietal bone and a cannula passed into the ventricle. Two hundred cubic centimetres of ventricular fluid were withdrawn and 140 c.c. of air introduced (*Fig.* 411).

The ventricular fluid was clear and colourless, cells 1 per c.mm. There were no red corpuscles. Total protein was 0·015 per cent. There was no excess of globulin, and the Wassermann reaction was negative. The patient was very drowsy after the ventriculography.

SECOND OPERATION.—On Nov. 5, 1931, a right subtemporal decompression was carried out under local anæsthesia. Considerable intracranial pressure was found. The patient stood the operation well, but afterwards became more drowsy and gradually got weaker. He suddenly collapsed and died on Nov. 21, 1931. He had been running a high temperature for three days. The wound had quite healed and was healthy.

PATHOLOGY.—A post-mortem examination was carried out by Dr. Carnegie Dickson. The body was that of a well-nourished, well-developed young adult male, with little of note externally except that the figure showed a tendency to the female type. There was marked general flattening of the convolutions, more especially of the left hemisphere, which appeared to be slightly larger than the right. The larger surface veins were somewhat dilated and the Pacchionian bodies about the vertex were numerous and prominent. Over the central portion of the base, e.g., over the pons and the interpeduncular space and dilated infundibulum, there was some thickening of the pia-arachnoid.

On horizontal section of the brain at the level of the upper surface of the corpus callosum, the lateral ventricles were found to be very considerably dilated, especially the left, and the section at this level passed through a pearly 'epidermoid' or 'cholesteatomatous' tumour to the left side of the middle line, just posterior to the central point of the hemisphere, and occupying roughly the normal position of the left optic thalamus, which was displaced by the tumour forwards and outwards. This tumour had evidently arisen from the pineal region, the tumour lying mostly to the left side of this, pushing downwards the corpora quadrigemina and lamina quadrigemina, and compressing the subjacent aqueduct of Sylvius, and thus producing the hydrocephalus. The body of the pineal gland was still present, about the size of a small cherry-stone, and apparently more or less independent of the tumour, which, however, was in contact with its upper and left surface. The central portion of the pineal was removed for section, and the remaining sides of the gland sewn together to preserve the continuity of the specimen. The tumour was about the size of

a large walnut, or small plum, and it reached and pushed downwards and backwards the upper and anterior part of the cerebellum.

On the right side of the brain, just external to the dilated posterior ventricular horn, there was considerable softening and hæmorrhage due to the compression, and the cerebrospinal fluid had evidently ruptured outwards at this point during the removal of the specimen. The right optic thalamus showed considerable bulging into the dilated right lateral ventricle, suggesting the possibility that this also contained tumour, but on cutting into it this was disproved and it was found to be due merely to pressure displacement by the tumour to the left side, pushing it towards the right and upwards. Sections of the tumour itself had a glistening pearly white iridescence, suggestive of the presence of cholesterol. Horizontal sections at a lower level showed much the same appearance, with dilatation of the ventricles, including the third ventricle, thus producing the prominent infundibulum as seen from below.

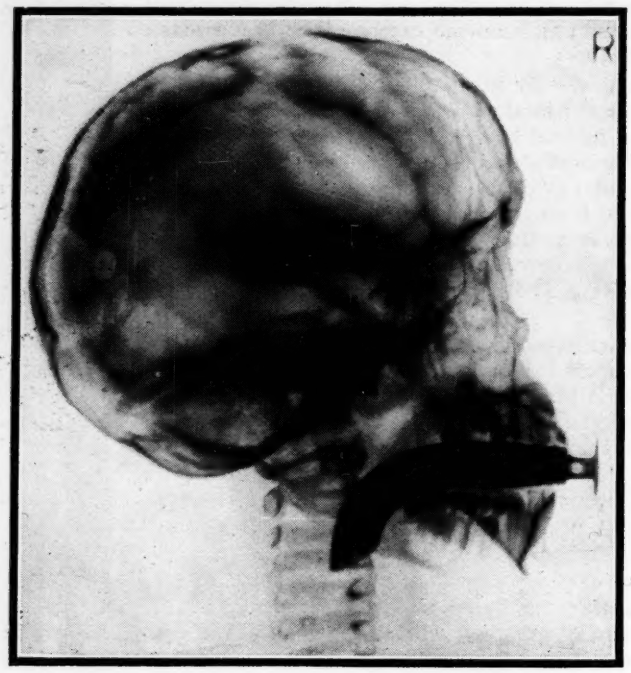

FIG. 411.—*Case* 4. Radiograph after ventriculography, showing dilated lateral ventricles and area of pineal tumour just beneath the corpus callosum.

HISTOLOGICAL EXAMINATION.—Sections from various parts of the pearly tumour showed it to be a typical 'epidermoid', consisting of a series of cysts or tumours, showing a concentric laminated appearance due to the production from the periphery inwards of squamous epithelium. The outer or formative layer in most of these cysts is much degenerated, or has largely disappeared, i.e., is now more or less inactive. Where it persists, it shows a tendency to the production of multinucleated plasmoidal squamous cells. Here and there, however, the formation of outward budding and the production of further small cysts at the periphery of the main mass persist. The central portions of the cysts consist of 'desquamated' epithelial cells and debris, including cholesterol crystals.

Sections of the pineal itself show at some parts more or less normal pineal structure, but at others there is distinct proliferation, with the production of what may be considered a simple pinealoma, involving more especially the larger pineal cells, and with little or no proliferation of the so-called 'small lymphocyte-like' cells.

The adenomatous cells are somewhat loosely arranged, the stroma varying in amount and in some parts being scanty and containing numerous thin-walled blood-vessels.

Case 5.—George W., aged 32, came under observation in March, 1932, complaining of giddiness and some difficulty in walking. The patient was a bank clerk, and was able to do his work until February, 1932, when he had an attack of influenza which kept him in bed for three weeks. On getting out of bed he found he was very unsteady on his feet, and could not stand alone. He was treated with tonics and massage, but did not improve.

On Examination.—When seen on March 10, 1932, he appeared to be somewhat dull and listless. His pupils were dilated and reacted sluggishly to light. There was bilateral papillœdema, there being five diopters of swelling in the right eye and four in the left. Except for slight bilateral deafness, the other cranial nerves appeared normal. There was a slight lateral nystagmus to the right. Rombergism was marked, and the patient was quite ataxic. The deep reflexes were normal, and there was no impairment to sensation.

Lumbar puncture revealed a clear colourless cerebrospinal fluid under pressure; there were no abnormal constituents. The day following the lumbar puncture the patient was incontinent three times, and there was a well-marked lateral nystagmus. Also for the first time there was limitation of upward gaze, and a definite weakness of the right sixth cranial nerve. Both lower limbs became spastic two days later. Radiographs of the skull revealed a midline calcified pineal shadow. This case was looked upon as a typical pinealoma, and removal was advised.

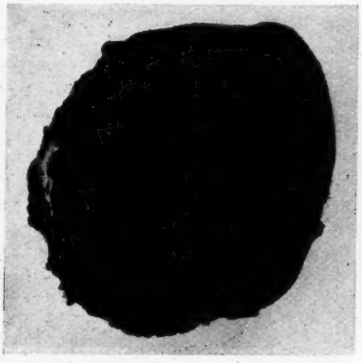

Fig. 412.—*Case* 5. Actual size of pineal tumour after removal.

Operation.—On March 21, under avertin and local anæsthesia, a large right occipito-parietal osteoplastic flap was turned down, the lateral ventricle tapped, and the dura mater opened. Bleeding was reduced to a minimum by the application of silver clips and the use of the diathermy knife. The falx was exposed and the inferior longitudinal sinus severed between the clips. The inferior border of the falx was divided to the extent of half an inch. The splenium of the corpus callosum was split with a curved diathermy knife, and a large pineal tumour exposed. Large veins could be seen surrounding the tumour. An incision into the tumour was made with the diathermy knife, and a definite capsule appeared to cover the tumour. With a curved dissector the tumour was shelled out of its capsule. The bleeding, which was not great, was controlled by the use of diathermy. The retracted cerebral hemisphere was replaced and covered by dura mater. A small piece of corrugated rubber tubing was inserted into the region of the tumour and brought out through the upper part of the wound. The bone flap itself was removed, as it was thought that as the capsule had been left behind, it would be advisable to give a course of X-ray treatments later. The patient stood the operation very well.

The following day the right lateral ventricle was tapped and 30 c.c. of blood-stained cerebrospinal fluid were withdrawn. The drainage tube was removed after forty-eight hours. The fifth day following operation lumbar puncture was performed—the fluid was under slight pressure and blood-stained. From this day recovery was uneventful, and the patient left hospital a month after the operation.

The tumour was about the size of a plum (*Fig.* 412), and was quite hard in consistency. Histologically the tumour was a typical pinealoma.

Subsequent History.—At the end of May, 1932, the patient was given a course of X-ray treatment; he seemed very well, and was able to go back to his office in September, 1932; he was able to walk quite well. There was no papillœdema, but still some lateral nystagmus to the right. The patient had a bad attack of influenza in December, 1932, which was followed by pneumonia which proved fatal in four days. Every effort was made to obtain an autopsy, but this was refused by the relatives.

Case 6.—Harry F., aged 27, was admitted to hospital on Feb. 5, 1935, complaining of headaches. The duration of the present headache was about three weeks, but he had had a similar bout of headaches one year previously. The headaches were mostly occipital, but sometimes were on the top of the head, mostly on the right side. They lasted for a quarter of an hour, and were worse in the morning. On two occasions he had vomited in the last

three weeks, and frequently was nauseated without vomiting. He had double vision for moderately distant objects, which was getting worse. Movement of the eyes was painful. He suffered from giddiness two or three times a week, mostly when standing. There was no tendency to fall to one side more than to the other. There was no deafness; no noises in the ear; no loss of power in any part of the body; and no unconscious attacks. There was no difficulty in speech, but he experienced difficulty in swallowing. There was no urinary trouble. He sometimes had numbness at the back of the head, but did not suffer from 'pins and needles' in the extremities.

There was no previous history of ear trouble or of trauma. The patient had fainted once five years ago, and had had Vincent's angina three years ago.

There did not appear to be any relevant family history; the father was alive and well; the mother died four years ago, aged 52, from septicæmia; there were two sisters and one brother, of whom one sister had developed asthma in the last two years.

ON EXAMINATION.—On examining the fundi on Feb. 12, 1935, the edge of the left disc was less distinct than that of the right. Papilloedema on the left side was in sharp contrast to a lesser amount on the right. The veins in both fundi were distinctly enlarged.

On Feb. 19, a stereoscopic X-ray examination of the skull showed a small rounded shadow of calcified pineal, a linear shadow situated at a certain distance from the rounded shadow, and quite close to the right temporal bone.

FIG. 413.—Radiograph after ventriculography, showing dilated lateral ventricle.

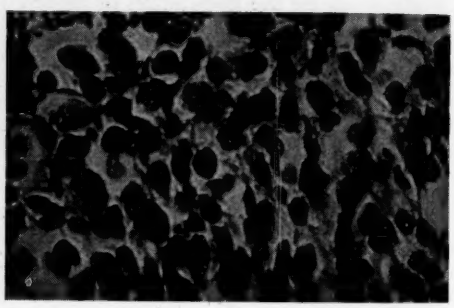

FIG. 414.—*Case* 6. Histological appearance of pineal tumour. (× 320.)

On Feb. 24 examination of the fields showed no abnormality. The patient continued to complain of severe headaches, and diplopia was still present.

OPERATION.—Ventriculography was performed on March 7. Both lateral ventricles were very dilated (*Fig.* 413). The patient was given avertin anæsthesia with gas, oxygen, and ether. A large flap was turned down over the right occipito-parietal region. The dura was quite tense, and the lateral ventricle was therefore tapped and some 80 c.c. of fluid withdrawn. The dura mater was then incised and the occipital pole of the brain was retracted outwards. The inferior border of the falx was now incised after having clipped the inferior sagittal sinus by means of silver clips. The splenium of the corpus callosum was pushed upwards by the underlying tumour; the splenium was cut through with a knife and the tumour exposed. It was a vascular tumour and a portion was removed with punch forceps. It was considered impossible to remove the tumour owing to the great vascularity, and therefore the occipital pole of the brain was replaced and the dura held together by three interrupted sutures; the bone flap was removed and the scalp united by a double row of interrupted sutures. The patient stood the operation very well, and, after three weeks, deep X-ray therapy was given through the defect in the skull made by removal of the bone flap.

The portion of tissue removed showed a typical pineal tumour, with plenty of large cells (*Fig.* 414).

SUBSEQUENT PROGRESS.—The patient was discharged from hospital two months later, but the stigmata of the pineal tumour, due to pressure on the corpora quadrigemina, still persisted.

The patient was admitted on Oct. 19, 1935, for a second course of deep X-ray therapy; but this did not have a very beneficial effect, and the patient left hospital very little improved for this treatment. We were informed that he died a month afterwards at his home, no autopsy being obtained.

Case 7.—Herbert O., aged 23, was admitted to hospital on March 4, 1935, complaining of double vision, which was first noticed some six weeks prior to admission. The onset had been gradual and seemed to follow a series of headaches. The patient blamed his left eye, as he said the false image was to the left of the real one. There had been no vomiting or blurring of vision. His speech was normal and memory good. He had had no fits.

ON EXAMINATION.—The pupils were equal and reacted to light. There was absence of accommodation and of the upward and downward movements of the eyes. There was some slight ptosis of the left eye and some rotary nystagmus.

The cranial nerves appeared normal, with the exception of some weakness of the right seventh, ninth, and twelfth. There was no sensory loss in the arms, but some slight intention

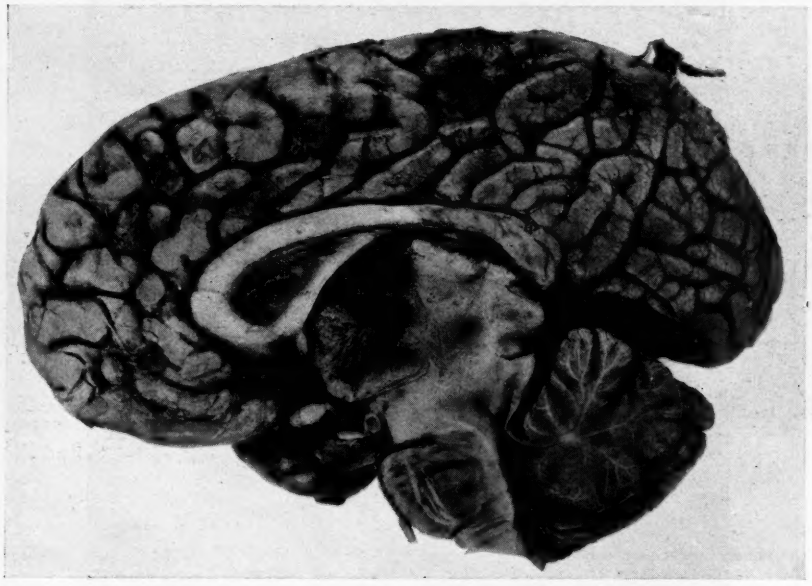

FIG. 415.—*Case* 7. Photograph of brain, showing position of pineal tumour.

tremor. Reflexes were increased in the arms, but were equal on the two sides. There was no weakness of the legs and no sensory loss. Knee- and ankle-jerks were brisk, and the plantars were extensor in type. There was bilateral papillœdema—right three diopters, left four diopters.

Lumbar puncture gave a clear colourless fluid with a pressure of 270 mm.

Cells	10 per c.mm.
Protein	50 mg. per 100 c.c.
Chlorides	710 mg. per 100 c.c.
Globulin test	Negative
Sugar	Within normal limits
Culture	Sterile
Wassermann reaction ..	Negative

A radiograph of the skull was normal except for some erosion of the posterior clinoid processes. The visual fields were normal.

The patient gradually became comatose and paralysed down the right side of the body, and died on March 10, 1935, some six days after his admission, without any operation being contemplated.

POST-MORTEM EXAMINATION.—At autopsy there was bilateral pulmonary collapse and enlargement of the heart. A very large tumour was found in the pineal region (*Fig.* 415). The photograph reveals the right half of the brain, showing a tumour, 2½ in. in diameter, occupying almost the whole of the third ventricle, and extending forwards to the anterior commissure, and below to the tuber cinereum. The tumour is infiltrating the superior corpora quadrigemina and the midbrain, extending to the interpeduncular space and the

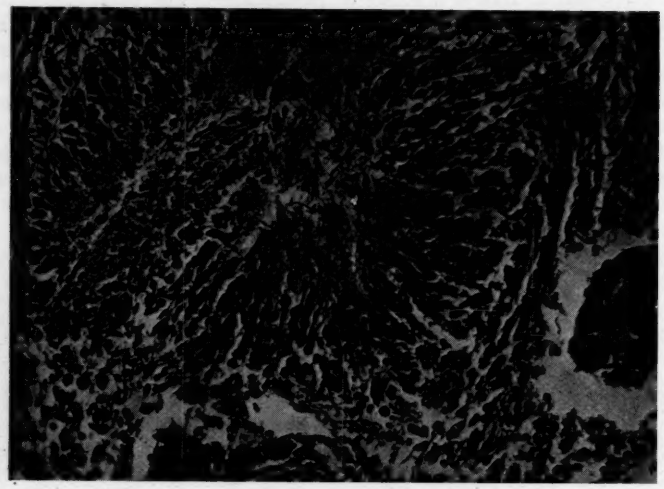

FIG. 416.—*Case* 7. Low-power picture of histological section of a pineal tumour.

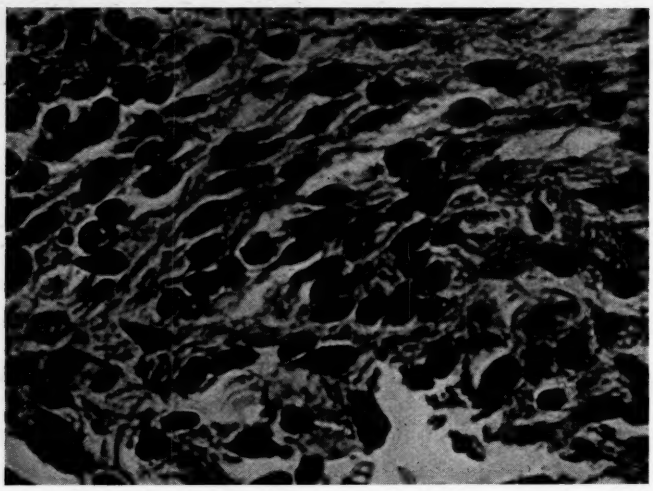

FIG. 417.—*Case* 7. High-power picture of histological section of a pineal tumour.

upper border of the pons. The point of origin of the tumour is not obvious, but from the mode of extension forwards into the third ventricle, and the direction of infiltration downwards and forwards into the midbrain, it would seem that the tumour arose in the pineal gland, which is no longer distinguishable.

HISTOLOGY.—Sections show a cellular tumour intersected by numerous capillaries. Some areas show the characteristic carrot-shaped cells arranged in circles, with their long protoplasmic processes forming a fibrillary network in the centre (pseudo-rosettes) (*Figs.* 416, 417).

Case 8.—Henry B., aged 11, came under observation on July 4, 1935, with a history of more or less constant headaches for two years. However, he was free for some weeks at a time. A week prior to admission he had repeated vomiting attacks which could not be stopped with any kind of treatment.

ON EXAMINATION.—He was a well-built and well-nourished boy, and quite intelligent. He complained of double vision and inability to look upwards beyond the horizontal plane. The pupils did not react to light, but reacted quite well to accommodation. The visual fields were normal. There was slight weakness of the right external rectus. There was bilateral papillœdema, more marked on the right side. The rest of the cranial nerves appeared normal. There was no loss of sensation in the body and the deep reflexes were normal. The cerebrospinal fluid was under tension, the manometric reading being 250. The fluid was clear and colourless and did not contain any abnormal constituents.

A radiograph of the skull (*Fig.* 418) revealed definite hammer markings owing to the increased intracranial pressure. The Wassermann reaction in the blood and cerebrospinal fluid was negative.

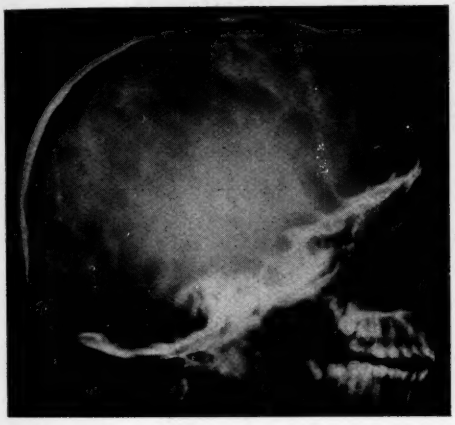

FIG. 418.—*Case* 8. Radiograph demonstrating hammer marking owing to the increased intracranial pressure due to a pineal tumour.

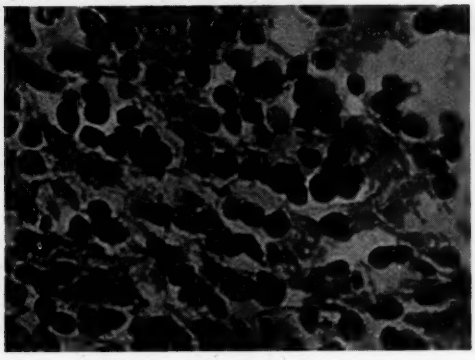

FIG. 419.—*Case* 8. Histological picture showing appearance of a pineal tumour. (× 320.)

Four days after admission the patient was found to develop skew deviation of the eyes on looking at objects in front of him, and the double vision became constant.

OPERATION.—A ventricular puncture was performed and 100 c.c. of air injected into the lateral ventricle. Ventriculography revealed bilateral dilatation of the lateral ventricles. A diagnosis of pineal tumour was made, and a large osteoplastic flap was turned down over the right occipito-parietal region. The lateral ventricle was tapped, and the occipital pole of the brain retracted outwards through the opening in the skull. The splenium was cut through, revealing a large pineal tumour. A portion was removed for examination and the operation was terminated. The general condition of the patient improved somewhat and the wound healed well.

The microscopical examination revealed an undifferentiated form of pinealoma (*Fig.* 419).

SUBSEQUENT PROGRESS.—After three weeks deep X-ray therapy was given to the pineal region through three ports of entry, some nine treatments being given, and the boy was discharged on Sept. 1 with very slight papillœdema and slight ataxia. On writing to the patient three months later from the follow-up department it was found that the boy had died in his sleep six weeks after leaving hospital and no post-mortem examination was held.

Case 9.—The specimen was obtained from a brain supplied to the Anatomy Department of King's College, London. No history of the case was available. A median longitudinal section of the brain showed a cyst which occupied the centre of the pineal body and compressed the quadrigeminal plate of the midbrain. The aqueductus cerebri was also compressed, but it was not completely obstructed, and there was no marked distension of

the third or lateral ventricles (*Fig.* 420). The pia mater around the pineal body and neighbouring parts was considerably thickened.

The pineal cyst was removed for microscopical examination, and serial longitudinal sagittal sections were cut and stained with hæmatoxylin and eosin and with picro-indigo-carmine.

These showed that the cavity of the cyst was formed by the breaking down of the central part of the pineal body. Its wall showed, in a modified form, the structure of the pineal gland. There was an epithelial stratum lining the cavity, the tissue immediately bounding the lumen being fibrillar and glial in nature. A middle zone, which formed the major part of the thickness of the cyst wall, showed typical parenchymatous pineal cells. These were of small size and had large nuclei, with only a small covering glial tissue, which forms the supporting tissue throughout the whole thickness of the cyst wall.

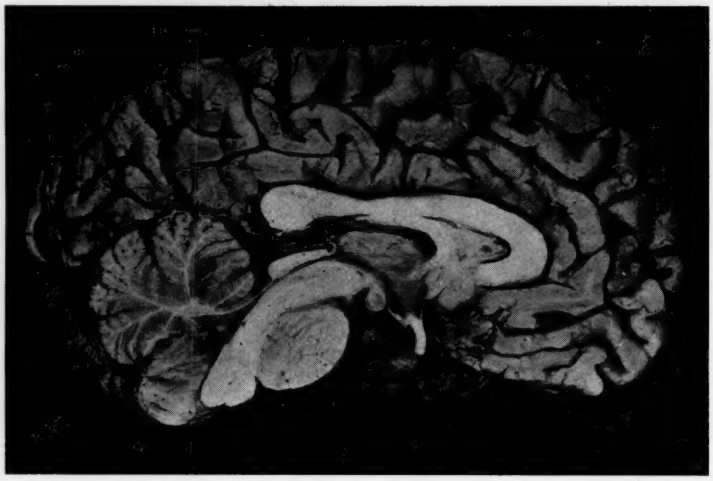

FIG. 420.—Mesial section of the brain, showing large pineal cyst lying between the splenium of the corpus callosum and the corpora quadrigemina.

There were some irregular plaques of calcareous deposit in the wall of the cyst, and corpora arenacea were abundant in the surrounding membranes, but were not present in the actual wall of the cyst.

Lying dorsal to the pineal body was a tubular diverticulum of the ependyma, which extended the whole length of the pineal body. It opened into the third ventricle at the suprapineal recess, and contained groups of choroidal villi, which projected into its lumen. This represents the persistent dorsal sac which is present in fœtal life, and is formed as a tubular outgrowth from the roof of the posterior part of the third ventricle. It would probably have contributed to the secretion of the cerebrospinal fluid. Should its opening have become blocked, it might have given rise to a thin-walled cyst, which would have differed from the pineal cyst described above in having a wall lined with ependymal epithelium, and most probably containing tufts of choroidal villi projecting into its lumen.

CONCLUSIONS

The surgery of the pineal organ, although yet in its infancy, may be said to be advancing rapidly owing to the fact that neurological diagnosis becomes more established and more accurate each year.

The symptomatology tends to be more definite: there is usually a severe degree of raised intracranial pressure, associated with headache, vomiting, papillœdema, epileptiform fits, and some cranial nerve paralysis. The eye signs are

definite, with loss of pupillary reaction and failure of upward movement of the eyes.

Operations for the removal of pineal tumours have become standardized; and even if the complete removal cannot be undertaken, a post-operative course of deep X-ray therapy will complete the cure, as the majority of pineal tumours are radio-sensitive.

There is no reason why the operative mortality should not be reduced to a very low figure and the results become as good as those for the removal of a pituitary tumour.

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FRACTURES OF THE SHAFT OF THE FEMUR
A NEW METHOD OF TRACTION AND IMMOBILIZATION

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FRACTURES of the shaft of the femur must in many instances be regarded as the most difficult and anxious of fracture cases which we may be called upon to treat. The majority of such fractures in adults occur in strong healthy individuals, to whom, in the capacity of wage earners, a good functional result is of the utmost importance. Figures published by Wevill and Wallace[1] in 1934 regarding the after-results of treatment give considerable cause for disquiet: in this series perfect results were obtained in only 40 per cent of cases, and good results in a further 23 per cent; in 37 per cent of cases the results were indifferent or bad.

The large variety of methods at present employed in the treatment of fractures of the shaft of the femur suggests that no one has been found to be entirely satisfactory. In nearly all cases some form of continuous traction is applied to correct shortening, but the methods of supporting and immobilizing the limb during the application of the traction vary very considerably. There can be little doubt that the most efficient control of the fracture, combined with the maximum of comfort to the patient, is to be obtained by the use of some form of suspended splint, which is so counterbalanced that it follows the movements of the patient in bed without the direction of the traction being appreciably altered. Such requirements are admirably fulfilled by traction applied in a Thomas splint which is suspended by counterbalancing weights at both ends, but some difficulties are encountered in this method of treatment. It is universally taught that an accurately fitting ring is the first essential of a Thomas splint, but few hospitals offer such a selection of these splints as to make this ideal attainable in every case. Even with an accurately fitting splint, patients frequently complain of the discomfort caused by pressure of the ring on the perineum or at the ischial tuberosity. Furthermore, it is generally agreed that the knee should be slightly flexed, or that flexion should be possible during treatment. This may be provided for by means of a flexion piece attached to a Thomas splint, but the method is not very satisfactory, as the elevation of the distal end of the splint results in pressure of the ring against the skin below the anterior superior spine.

These disadvantages are largely overcome by the substitution of a Hodgen splint. Where this splint is used, accurate fitting is in no way essential, flexion of the knee is provided for by angulation of the splint, and counter-traction is simply dependent upon the weight of the patient's body. This splint has not, however, enjoyed any widespread popularity, due to the criticism, probably largely undeserved, that sufficient pull cannot always be obtained in the absence of a fixed point of countertraction.

In both Thomas's and Hodgen's splints the method of suspending the limb in the splint by means of domette or calico slings is not very satisfactory, as the

tendency of these slings to wrinkle into folds or to become slack necessitates constant examination and adjustment. For this reason the immobilization must be regarded as being far from efficient.

Böhler's splint (or Böhler's modification of Braun's splint) has been widely used during the last few years. In Böhler's hands this splint undoubtedly gives excellent results. If in other hands the method has proved less satisfactory, this may be largely due to the neglect of certain precautions which Böhler describes as being essential for the efficient functioning of the splint. Particularly necessary is the provision of a foot-rest for the sound limb, without which the patient is inexorably drawn into the splint, with resultant pressure of the inner angle against the perineum. Böhler's splint, however, suffers the general disadvantages of all 'fixed' splints (i.e., resting on the bed), in that movement at the site of fracture is likely to be caused by any change in position of the patient's body, and by the raising of the pelvis for nursing purposes.

Böhler has taught that an essential aim in the treatment of fractures is immediate and accurate reduction of the fracture, followed by as efficient immobilization as is possible. These principles are now generally accepted in the treatment of fractures in all situations, but in cases of fracture of the shaft of the femur, the requirements are seldom satisfied by the present methods of treatment.

I would venture to suggest that immediate and accurate reduction of such fractures is most easily and most efficiently obtained by some form of screw traction. When such traction is applied in the axis of the shaft, lateral displacement will usually be corrected as soon as the shortening has been overcome, as the fragments are pressed into alinement by the elastic covering of the muscles. The necessity, therefore, for lateral traction or pressure pads is immediately abolished. For the reduction of transverse fractures, screw traction has a special application. In such cases, continuous traction is frequently found to be unsatisfactory, owing to the difficulty of obtaining end-to-end apposition of the fragments; if a weight sufficient to disengage the fragments is left on for more than a very short time, over-distraction is liable to occur. Where screw traction is used, accurate reduction is greatly facilitated; the traction is applied till the fractured surfaces are felt to grate together, after which it is partially relaxed, when the pull of the muscles tends to prevent re-displacement.

If the reduction is to be followed by immobilization, it is a *sine qua non* that the traction must be applied with the limb in the position in which it is to be fixed. It is now generally accepted that in fractures of the femoral shaft, the leg should be immobilized in at least some degree of flexion at both hip- and knee-joints. In this position accurate reduction is easier, the leg can be suspended clear of the bed, and subsequent stiffness of the knee is minimized. It is essential, therefore, that the traction should be applied with the limb in this position of flexion. An apparatus which fulfils these requirements is described below.

If we are to attempt an immediate reduction of the fracture it is obvious that efficient immobilization after this procedure is of the greatest importance. This can be most readily obtained by an unpadded plaster-of-Paris cast, which has very definite advantages over any type of splint, in that an accurate fit is assured for every patient, immobilization is much more effective, and repeated adjustments become unnecessary. After the patient's return to bed, the plaster case can be suspended and counterbalanced, so that it has all the advantages of a suspended splint.

Although it is suggested that a plaster case constitutes the most efficient type of splint for the thigh, the immobilization secured by such means is in itself inadequate to prevent re-displacement. The femur is so thickly padded with muscles that absolute control of a recent fracture cannot be expected, even in a plaster case extended up on to the trunk. Even the best of unpadded plasters, carefully moulded round the pelvis, is liable to become displaced upwards, causing over-riding or angulation at the fracture.

It is advisable, therefore, that continuous traction should be applied to the leg after the patient's return to bed. If this is maintained during the first four or five weeks of immobilization, the danger of re-displacement is almost entirely obviated. In addition, continuous traction greatly reduces the likelihood of circulatory disturbance due to swelling of the limb within the plaster case, and the patient is made much more comfortable, since pressure of the plaster against the perineum or adductor region is avoided. Such continuous traction is applied in the line of the femur, by hanging weights on to the skeletal traction appliance (Kirschner wire, Steinmann pin, or ice-tong caliper) which was used for the screw traction and has now been incorporated in the plaster case. Only a small weight is necessary—sufficient to prevent re-displacement.

DESCRIPTION OF THE APPARATUS

Before attempting to give a detailed account of this method of treatment, it is necessary first to describe one special piece of apparatus which will enable

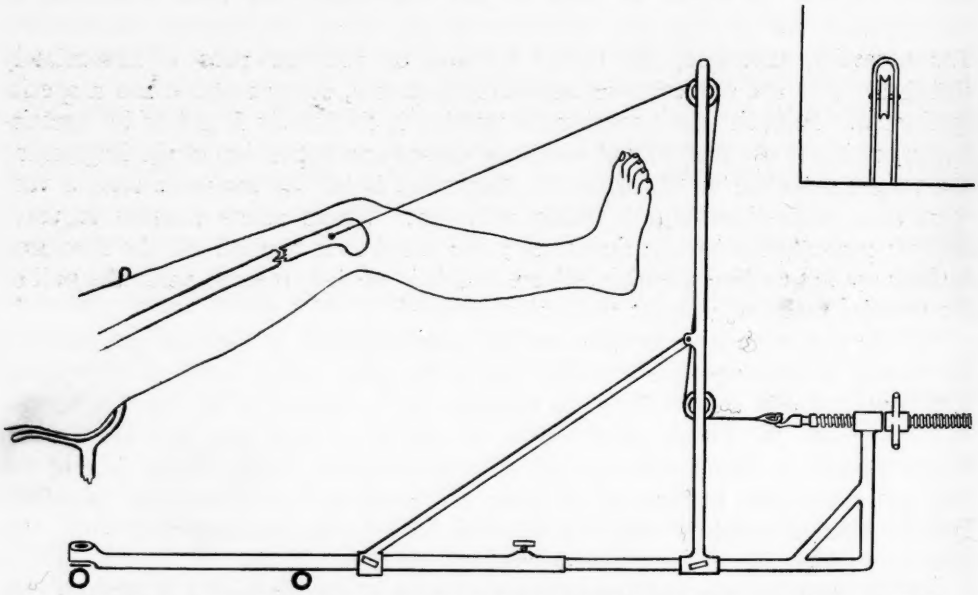

FIG. 421.—Diagram to show the method by which screw traction is applied to the femur with both hip- and knee-joints in a flexed position. This particular appliance has been designed for attachment to the portable traction table illustrated in *Fig.* 422, but some similar form of pulley system could no doubt be made up to fit on to any existing orthopædic table.

traction to be applied to the femur with the hip- and knee-joints in the flexed position. The principle of the appliance is indicated by the diagram (*Fig.* 421). It is essentially a form of pulley system, by means of which the line of traction

may be raised 20° to 25° above the horizontal. A thin wire rope, which is sufficiently flexible to pass over the pulleys, makes an ideal connection. An attachment which would provide for these requirements could no doubt be made up to fit on to any existing orthopædic table. The particular appliance or flexion piece illustrated has been designed for attachment to a portable traction table, which is in use in the Royal Infirmary, Edinburgh.

This traction table* (*Figs.* 422, 423), which has been described elsewhere,[2] consists of two frames of tubular steel which telescope one into another. The one frame has a collapsible canvas 'stool' for supporting the head and shoulders, and

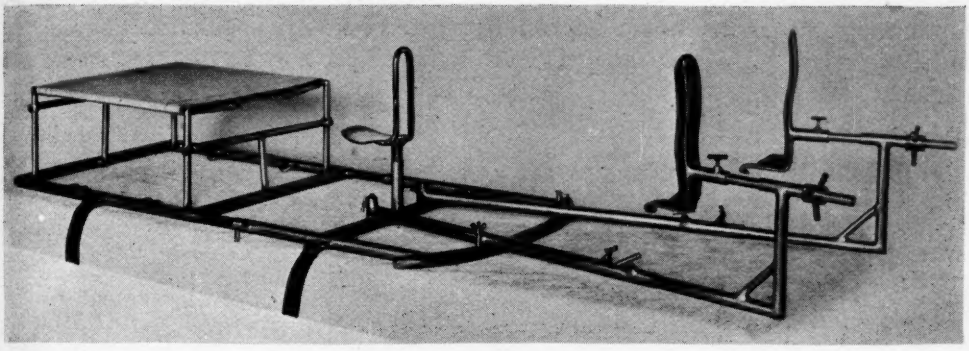

FIG. 422.—The portable traction table described in the text.

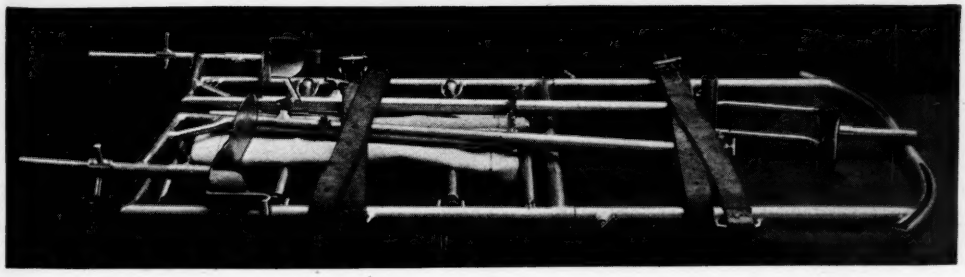

FIG. 423.—Portable traction table when folded. Dimensions: 3 ft. 6 in. by 1 ft. 9 in.

is adjustable in relation to the other frame, which bears the pelvic rest. This is of a new design in that the counter-pressure is taken by two uprights against the ischial tuberosities or sacro-tuberous ligaments, instead of by a single upright against the perineum. The traction rods or leg pieces, also of telescopic tubing, pivot round axes corresponding in position to the hip-joints, and are adjustable in any degree of abduction. Foot-pieces, which are mounted at the ends of the traction rods, are adjustable in rotation; to these screw traction can be applied. If the foot-pieces are removed, a simple hook is exposed at the end of the screw for use where skeletal traction on the lower leg is desired.

When not in use, the apparatus folds flat to dimensions of 3 ft. 6 in. by 1 ft. 9 in. The total weight is 30 lb.

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* Supplied by the Medical Supply Association Ltd.

TECHNIQUE

Preliminary radiographs are taken to determine the nature and site of the fracture. A Kirschner wire is passed through the lower end of the femur. The wire is drilled through from the medial side, at a point ½ in. in front of, and 1 in. above, the adductor tubercle. In this situation, the wire is well removed from the attachment of the ligaments of the knee-joint, and we are able to avoid the possibility of any reactive changes in these structures, which may predispose to joint stiffness afterwards (Stirling). The wire may alternatively be passed through the tuberosity of the tibia, but in my experience accurate reduction is more easily obtained by the direct pull on the femur—particularly in cases of supracondylar fracture, where the deformity of backward angulation has usually to be corrected. A Steinmann pin or ice-tong calliper may be used instead of the Kirschner wire.

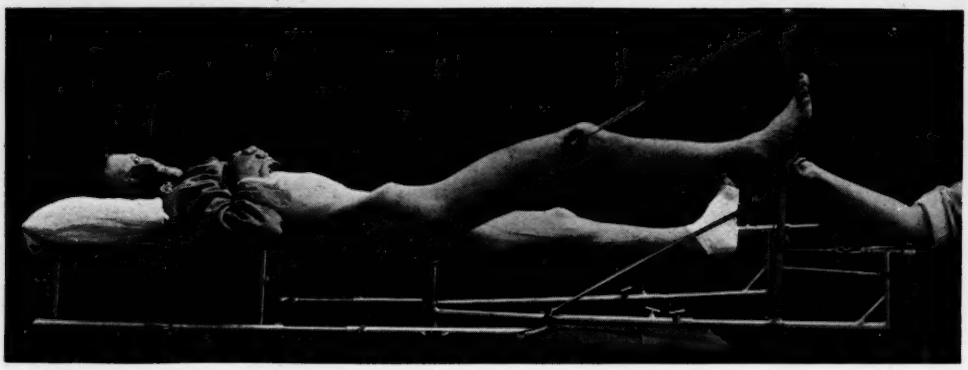

FIG. 424.—Photograph of patient during the application of traction on the right femur. (The sound limb is steadied by bandaging to the foot-plate on that side of the table, and by applying sufficient traction to prevent tilting of the pelvis.)

The patient is then placed on the traction table. The sound limb is steadied by bandaging the foot to the foot-plate, and applying slight traction. (Only sufficient traction to prevent subsequent tilting of the pelvis is necessary.) On the other side of the traction table, the special flexion piece has been incorporated, and traction is applied to the fractured limb as indicated in the photograph (*Fig.* 424).

Whenever screw traction is applied, it is essential that some form of tensometer be included in the apparatus, in order that the degree of tension may be measured with at least a reasonable amount of accuracy. The spring balances at present available for this purpose appear to be unduly cumbersome in length or bulk, but a very simple little instrument has been made for me which fulfils the purpose.* This consists of a short strong spring which has a graduated scale alongside giving readings up to 100 lb. It is illustrated in *Fig.* 426.

This graduated spring is incorporated in the traction system between the Kirschner stirrup and the wire rope on the flexion piece, as indicated in *Fig.* 425. The intermediate connection is made by a piece of chain, which allows for easy adjustment, and is subject to less 'give' than rope.

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* Supplied by Arch. Young & Son, Ltd., Edinburgh.

In the case of transverse fractures, as much as 60 to 90 lb. traction may be necessary to reduce the overlapping of the fragments sufficiently to allow end-to-end apposition. (This, however, includes the amount of traction necessary to

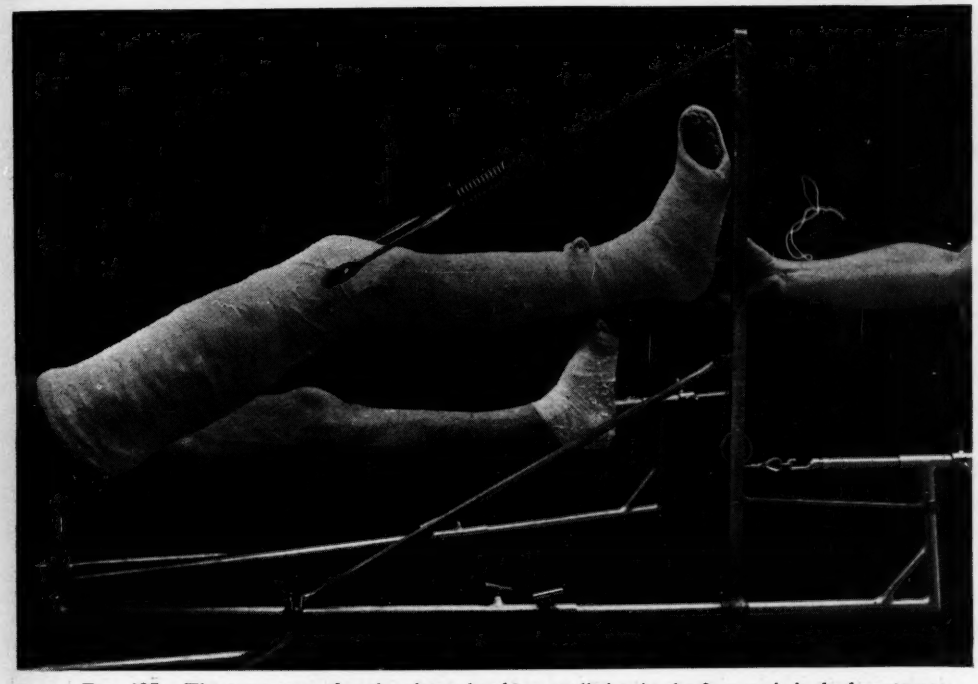

FIG. 425.—The same case, after the plaster has been applied. As the fracture is is the lower two-thirds of the shaft, the plaster case does not include the pelvis, but is carried as high an possible on the limb. Note the loops of plaster bandage made on the front of the cast above the ankle. (*Figs.* 422–425 *kindly supplied by the Medical Supply Association.*)

counteract the force of gravity of the limb). When the overlapping of the fragments has been overcome, the ends can usually be made to grate together. The traction is then relaxed to about 50 lb., when the pull of the muscles will keep the ends in apposition. In the case of oblique fractures, a pull of 50 to 60 lb. usually brings about very satisfactory reduction.

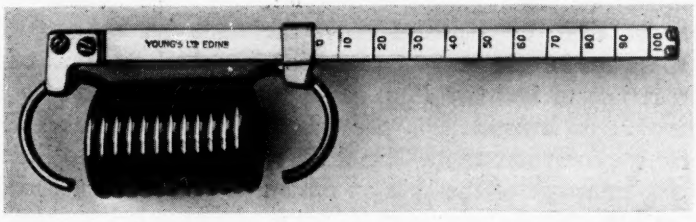

FIG. 426.—Tensometer spring, graduated up to 100 lb. ($\frac{1}{2}$ scale). (*Kindly supplied by Arch. Young & Sons, Ltd.*)

If a portable X-ray apparatus is available, it is of course very helpful to have a film taken and developed immediately before the application of the plaster. In the absence of such facilities, reliable information as to the position of the fragments can be obtained by the method suggested in *Fig.* 427. Two straight needles

of equal length are inserted on the lateral side of the thigh above and below the fracture; these are pushed in at right angles to the axis of the femur till their points impinge on the bone. A comparison of the depth to which they have been inserted indicates fairly clearly the relative position of the fragments. The same procedure is then repeated from the anterior aspect. Such methods are particularly helpful in securing accurate reduction in cases of transverse fracture; in oblique fractures they are probably unnecessary.

When the fracture is in the upper third of the shaft or is per-trochanteric, traction should be applied (and the leg subsequently immobilized) in the position of abduction and slight lateral rotation, in order that satisfactory alinement with the short upper fragment may be obtained.

After the reduction is regarded as being satisfactory, the plaster case is applied. In cases of fractures of the upper third of the femur it must be carried up on to the trunk, in order that the position of abduction may be maintained (*see Fig.* 429). In fractures of the lower two-thirds, there is no necessity to include the pelvis in the plaster case, if, as is advised, continuous traction is to be maintained afterwards: a cast which extends only up to the groin (*see Fig.* 425), allows the patient a very much greater freedom of movement, and is much more contentedly tolerated. In the case of the hip plaster, small pads of felt are placed over the spine and sacrum, and over the anterior iliac spines. In both plasters a small felt pad is laid over the back of the heel and the malleoli. Apart from this, both plaster cases are entirely unpadded. The upper edges of the casts are made fairly thick and are well smoothed to prevent chafing of the skin. In the case of the short plaster (enclosing the limb only), it is exceptional for any complaint of discomfort to be made, and in the case of the hip plaster the cutting of a window over the abdomen minimizes the inevitable sensation of constriction.

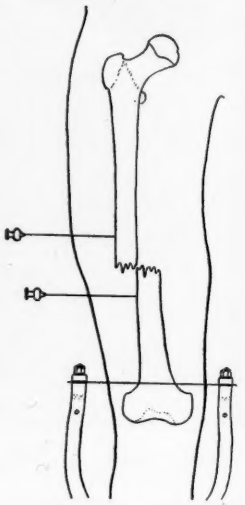

FIG. 427.—Drawing to show how, in the absence of portable radiographic facilities, the accuracy of reduction of a fracture may be gauged by the insertion of two needles of equal length above and below the fracture. This is done from both lateral and anterior aspects.

The Kirschner wire is incorporated in the plaster, the skin at the site of puncture being covered by a small spirit swab wound round the wire. Two loops of plaster bandage are made on the front of the case above the ankle (*see Fig.* 425); these are for the purpose of suspending the lower part of the case after the patient's return to bed (*see Figs.* 428-430).

The question of anæsthesia is one of individual preference. No anæsthetic is required for the insertion of the Kirschner wire. This causes little pain beyond that due to the puncture of the skin on each side of the limb, and is comparable merely to two hypodermic injections in quick succession. A short anæsthesia is usually necessary during the application of the traction, though some patients who dread an anæsthetic are quite content to suffer the discomfort if the pelvic rest is well padded with wool.

Compound fractures may be treated in exactly the same manner after the wound has been excised and stitched. A window may be cut in the plaster case to allow for dressing.

During the return of the patient to the ward, the leg is carefully held by an assistant, who maintains manual traction upon it in order to prevent re-displacement. As soon as he is placed in bed, continuous traction is applied to the Kirschner wire incorporated in the plaster, and is maintained in the line of the femur as shown in *Fig.* 428. Only sufficient weight to prevent re-displacement is attached—10 to 15 lb. in the case of a transverse fracture (in end-to-end apposition), and 15 to 20 lb. for an oblique fracture, have been found to be adequate. The distal end of the plaster case is suspended by vertical cords so that the lower leg is horizontal (*Fig.* 428). The foot of the bed is raised, so that counter-traction may be provided by the weight of the patient's body.

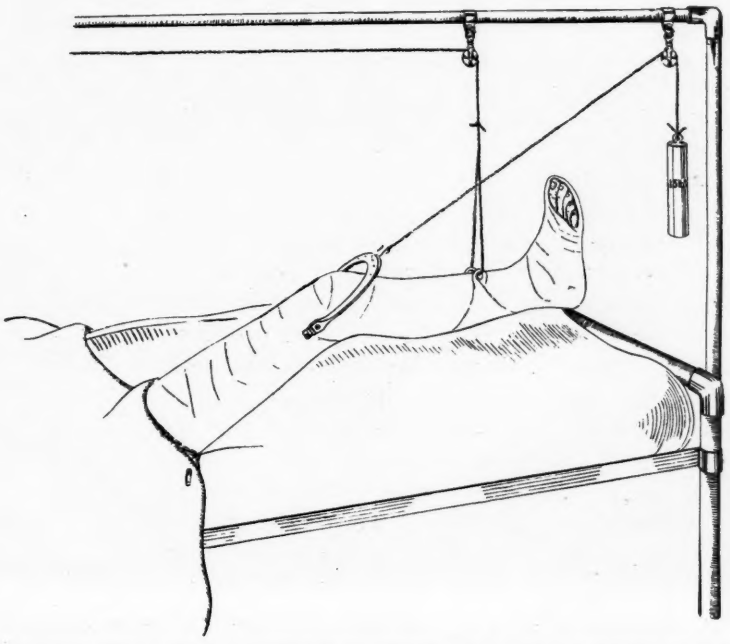

FIG. 428.—Drawing to show the method of suspension of the plaster case after the patient's return to bed, and how traction is maintained in the line of the femur.

For the first twenty-four hours a careful watch is kept on the colour of the toes, and if there is any suggestion of circulatory disturbance, the cast must immediately be split down the front. If, however, the plaster has been carefully applied, and continuous traction is maintained, this should never be required.

The traction is continued for four to five weeks, during which time two or three radiographs have been taken to confirm that the position has been maintained and to estimate the progress of healing. After the discontinuation of the traction, the subsequent treatment may be varied according to the individual case, or to the preference of the surgeon. The plaster cast may be extended up on to the trunk, or a new plaster applied, and the patient discharged home. In the case of a supracondylar fracture the patient may be discharged in the original plaster, if this has remained tight-fitting, or a new cast may be required; later, a walking iron may be incorporated. Alternatively, where the home conditions of the patient render continued hospitalization necessary, the leg may be retained in the suspended

plaster splint for eight to ten weeks in all, after which the patient is discharged in a walking calliper splint.

SUBSEQUENT PROGRESS

During the last two years, this method has been employed in most cases of fracture of the shaft of the femur treated in the wards of the Edinburgh Royal Infirmary to which I am attached. In nearly all cases the method of screw traction has rendered accurate reduction of the fracture a comparatively simple procedure, and no necessity for any operative interference has arisen. The immobilization provided by the unpadded plaster cast has proved to be most satisfactory. Only in two cases, both of them transverse fractures, did re-displacement occur. In

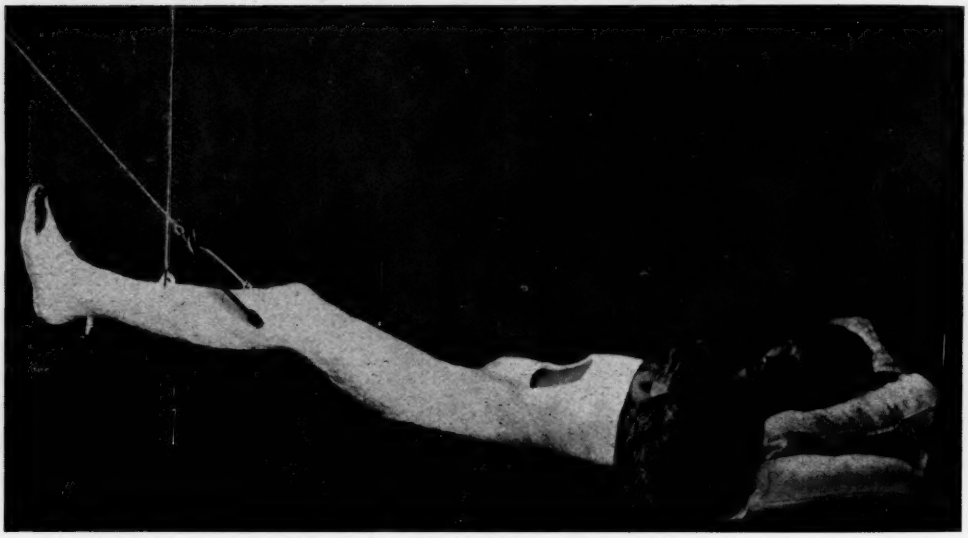

FIG. 429.—A case of fracture of the upper third of the shaft of the femur. Reduction has been effected by screw traction, and the leg is immobilized in the position of abduction and slight lateral rotation by a plaster case extended up on to the trunk. Note as before the method of suspension, and the maintenance of traction in the line of the femur (Kirschner wire passed through tibial tuberosity).

the first this took place during the return of the patient to bed, when the leg was allowed to rotate outwards while on the trolley; the second case was in a compound fracture, where the laceration of the muscular sheath around the bone may be regarded as a contributory cause; in addition, the cutting of a window in the plaster over the wound may have rendered the control less adequate. In both cases a second reduction was successfully maintained.

A notable feature has been the comfort which the patients have experienced with the leg immobilized in plaster. The maintenance of continuous traction has prevented pressure from the upper limits of the cast, and the method of suspension has allowed free movement in bed (*Figs.* 429, 430). Four cases had previously been treated for a short time in other splints, but because reduction had been unsatisfactory they were later subjected to screw traction followed by immobilization in plaster. In all cases the patients were appreciative of the increased comfort provided by the second method.

After four or five weeks, a few patients complain of pain at the back of the heel or at the malleoli due to pressure from the plaster cast; this is liable to occur even when these bony points have been carefully padded. It should be investigated at once, by cutting a window in the plaster over the tender area and subsequently replastering with fresh padding. Apart from this no adjustments have been found to be necessary.

A possible criticism of this method of treatment would be that the prolonged immobilization might lead to a troublesome stiffness of the knee-joint afterwards. But the extent of flexion (about 20°) in which the joint has been maintained appears to be an adequate safeguard against such disability. Even in cases

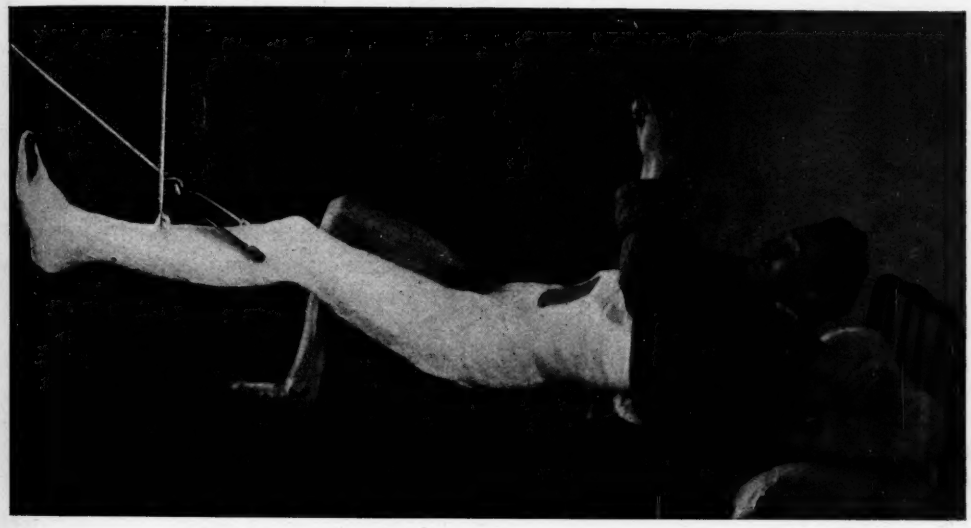

FIG. 430.—The same patient as in *Fig.* 429, photographed while raising himself off the bed. Note the freedom of movement afforded by the method of suspension.

immobilized for eight to ten weeks, painless movement between full extension and 30° to 45° of flexion is frequently possible within a few hours of the removal of the plaster, and 90° of flexion is usually obtained without difficulty within a week.

SUMMARY

It is maintained that many of the methods at present employed in treating fractures of the shaft of the femur are unsatisfactory, because of: (1) The difficulty with which accurate reduction is obtained; and (2) The inefficiency of the immobilization provided by present splintage methods.

It is suggested that the ideal to be attained is: (1) Immediate and accurate reduction, which is most easily obtained by screw traction; and (2) As complete immobilization as is possible—for this, an unpadded plaster cast is advised.

An apparatus is described for providing screw traction to the femur in the position most suitable for immobilization, i.e., with both hip- and knee-joints in a position of flexion.

Thereafter, only sufficient continuous traction to prevent re-displacement is necessary.

It is maintained that a suspended plaster cast is more comfortable for the patient than any other form of splint, and that there is no undue tendency to joint stiffness in cases treated by this method.

I am indebted to Mr. W. J. Stuart for his encouragement in this method of treatment, and to Mr. R. I. Stirling I owe my sincere appreciation of much helpful advice and criticism.

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PNEUMATOCELE CAPITIS

By J. B. G. MUIR, Tongshan, North China

Pneumatocele capitis is a rare condition in which a collection of air occurs under the pericranium of one or several of the bones of the skull, causing a tense swelling having more or less the outline of the bone over which it arises. Such swellings, which may show variations in size with the respiratory movements, are generally found in relation to the frontal bone, less commonly over the mastoid, and are caused by a pathological or traumatic communication between the frontal or mastoid air cells and the space between the raised pericranium and the bone.

The pericranium is closely adherent to the outer surface of the bones of the skull, and although it is raised from the bone by the well-known cephalhæmatoma of birth injury, it is almost invariably torn when the underlying bone is fractured in adults. Hence air is more frequently found in the dangerous area of the scalp, between the epicranial aponeurosis and the pericranium, giving rise to the condition known as diffuse emphysema of the scalp. In practice this is almost invariably the result of a fracture involving the frontal sinus, and as such a fracture usually traverses the anterior fossa of the skull as a ' fractured base ', it is an omen of serious import. In certain cases of injury to the base of the skull air may pass into the cranium, either extradurally—forming an extradural pneumatocele—or actually into one or other lateral ventricle. In view of the serious nature of the causal injury in such cases the primary mortality is high ; but a case has recently been reported by Engelhardt where, three months after a motor-cycle accident resulting in a fractured base of the skull, a patient presented himself complaining of headache and vertigo ; X-ray examination showed what was considered to be either an extradural pneumatocele or a collection of air in the frontal lobe, and evidence of a fissured fracture involving the region of the crista galli and traversing the frontal sinus. In this case rapid and spontaneous absorption of the air occurred.

Such complications following injury or disease in the mastoid region are extremely rare, and can only occur in a patient with abnormally developed mastoid cells. The following case, therefore, where as a result of mastoiditis in infancy a communication occurred between abnormally developed mastoid cells and the subpericranial layer of the scalp, resulting in the development of an enormous pneumatocele which ultimately covered the entire cranium, appears worthy of description. It is the more interesting in that following ' needling ' by a native physician a communication was made with the interior of the skull in the posterior fossa, causing in addition an extradural pneumatocele which gave rise to occasional nausea and headache.

CASE HISTORY

Chang Fu, a farmer, aged 24, suffered from a purulent discharge from the left ear during infancy, which continued for about two months and then ceased. When he was 4 years old a painless swelling appeared behind the left mastoid process, and slowly enlarged to the size of a walnut. It was soft on pressure, which caused slight pain in his ear, sometimes accompanied

by crackling sounds. This swelling did not trouble the patient in any way, and was observed to disappear gradually when he was 21 years old.

In January, 1935, however, the swelling reappeared behind the mastoid process, and in two months had increased to the size of an egg. It was painless, but as he was rather worried by his appearance he consulted a native physician, who punctured the swelling with a needle. Air escaped, and the swelling subsided, but for two weeks which the puncture wound took to heal, the patient suffered from considerable local pain and general headache.

In September, 1936, the patient felt a crackling noise in his left ear and the swelling suddenly reappeared, and in the course of a few weeks gradually enlarged, upwards, forwards, and to the right, until it ultimately involved the entire crown of the head. It was soft and painless and unattended by headache or dizziness, but he suffered from periodical attacks of nausea and vomiting. As he was contemplating marriage, and his appearance was the object of much ridicule, he came to hospital to see if any treatment was available, and was admitted.

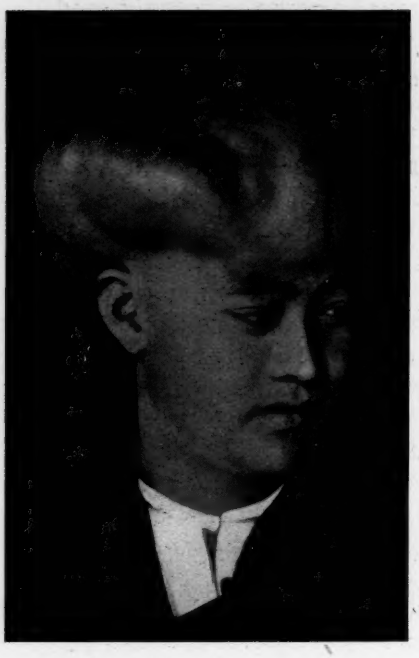

FIG. 431.—Showing condition of patient on admission with the head shaved. Note the anterior and lateral limits of the swelling.

His appearance was truly remarkable, the entire scalp being raised off the cranium and ballooned out to produce a turban-like effect (*Fig.* 431). On light palpation it was soft but elastic, and on deep palpation sharp pieces of bone could be felt in certain areas. There was no thrill, and no bruit was present on auscultation. Firm pressure equally distributed over the scalp caused no discomfort, and coughing caused no impulse in the swelling, which showed no variation in size with the respiratory movements.

Radiographs of the skull taken in the antero-posterior and lateral positions gave extraordinary pictures. Air surrounds the vault of the skull, lying between the raised pericranium—seen as a thin line—and the outer table of the bones of the cranial vault.

The attachment of the pericranium at the inter-osseous sutures, which limits the extravasation of blood from a fracture of the subjacent bone in a cephalhæmatoma, has been raised in numerous places from its attachment by the air, so that a large loculated cavity exists over the vault of the skull (*Fig.* 432). The stress on the pericranium at the sutures has resulted in the formation of spicules and processes of thin bone, resembling in principle the ossification which sometimes occurs in subperiosteal hæmatomas following trauma in the arm, namely, myositis ossificans (Watson Jones).

A 'cock's-comb' appearance is seen in the lateral radiograph (Fig. 433), produced by these fine bony spines growing from the attachment of the pericranium at the sagittal and lambdoidal sutures. Air can also be seen inside the skull in the posterior cranial fossa, lying between the inner table and dura mater, and the pressure of this extradural pneumatocele was probably responsible for the nausea and vomiting occasionally experienced by the patient.

In order to confirm the diagnosis aspiration was first performed, with dramatic effect. A large quantity of air escaped with a hissing noise and the ballooned-up scalp collapsed in folds over the patient's head.

It was decided to explore the actual condition of affairs present under the scalp, with a view to obliterating the space by causing firm adhesion of the raised scalp to the bones.

General physical examination showed the patient to be a normal healthy young man, with no contra-indications to general anæsthesia.

OPERATION.—On March 12, 1937, under open ether administered through a nasal tube, a triradiate incision was made over the cranium with the incisions meeting at the central point of the line joining the glabella to the external occipital protuberance. The two anterior incisions passed downwards and outwards on either side to the zygomatic processes of the frontal

bones, and the posterior incision downwards and backwards in the midline to the external occipital protuberance. The incisions were made in short sections, digital pressure controlling the bleeding on each side of the wound until the vessels were secured. Three flaps of scalp were thus marked out and raised. A large loculated cavity was found to exist between the scalp and the outer surface of the cranial bones. Loculation, however, was imperfect, free inter-communication occurring between the loculi, which corresponded to the individual bones

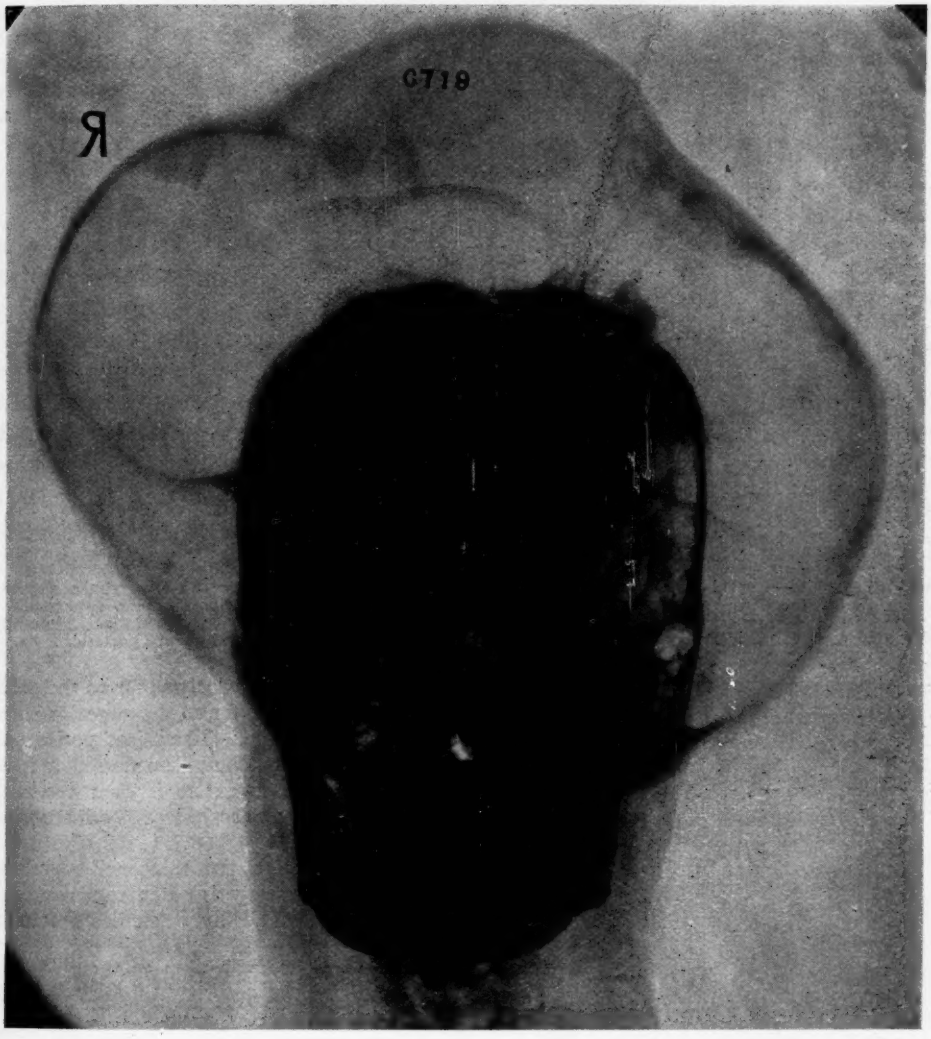

FIG. 432.—Antero-posterior view of skull and scalp tumour. A halo-like effect is given to the cranial vault by the separation of the scalp from the bones by air which has spread beneath the pericranium. In places fine septate-like spicules of bone can be seen connecting the outer table of the cranial bones to the inner surface of the raised scalp. Some irregularity is apparent in the midline of the skull over the sagittal suture. The extreme porosity of the left mastoid process is visible in this film, showing the shell-like nature of the superficial bone. The frontal sinuses are abnormally enlarged.

of the vault. The attachment of the pericranium to the sutures had been forced up by the increasing expansion of the air, and where this stress had occurred, spicules of bone had formed. The raised pericranium formed a thick membrane corresponding to the innermost layer of the raised scalp. The surface of the exposed outer table of the skull was quite bare. Patches of bleeding granulations were seen on either side of the medially placed sagittal

suture, suggesting in their situation connections with the underlying Pacchionian bodies and venous lacunæ on either side of the superior longitudinal sinus. Traced laterally the raised pericranium adhered to the surface of the bone in the area of the temporal crests, but was

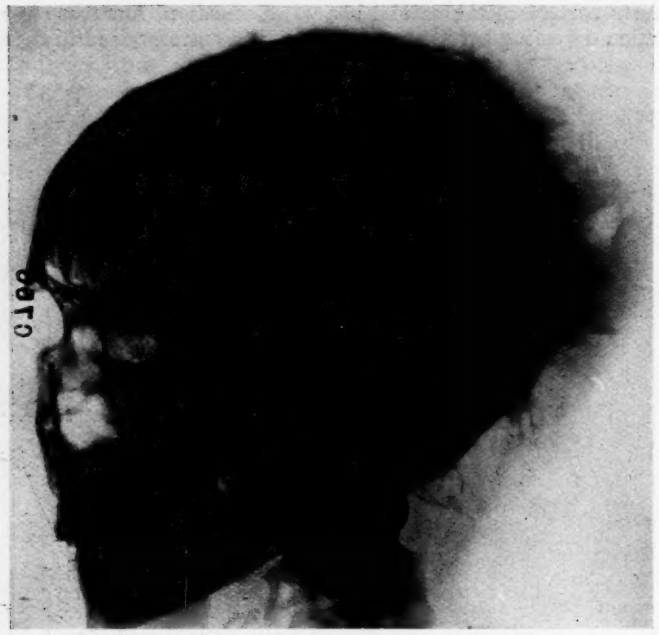

FIG. 433.—Lateral view of the skull taken after aspiration of the tumour had allowed the air to escape and the scalp to collapse. This lateral view shows the extraordinary cock's-comb appearance caused by bony spicules growing from the sagittal and lamboidal sutures from which the pericranium has been raised. Air shadows are visible within the cranium in the extradural space of the posterior fossa.

raised from the bone anteriorly as far as the orbital crests, and posteriorly as far as the superior curved line of the occipital bone. The raised pericranium was so smooth on its cranial surface that it was considered advisable to excise it over the raised area in the hope that the scalp would adhere firmly to the cranial vault.

By blunt dissection the thickened membrane was separated from the overlying epicranial aponeurosis, and excised. The bony spicules protruding

FIG. 434.—Photograph taken on the patient's discharge from hospital. His hair is growing, but one of the anterior limbs of the triradiate incision is still visible.

from the interosseous sutures were removed by dividing their bases with bone forceps. Bleeding from the oozing granulations was controlled by pressure with swabs wrung out of hot saline. In order to reduce the redundancy of the scalp to a size proportionate to the skull, portions of each scalp flap were excised, and the flaps were sutured together, as in Cushing's tripod incision. Drainage was provided through stab incisions made through the mid-point of the base of each of the triangular flaps, rubber sheet material being used.

The patient made a smooth and uneventful convalescence. Serum escaped from the drainage tubes in diminishing quantity for a few days and then ceased, when the drains were removed. After ten days a collection of serum under the lower part of the posterior flap was evacuated by an incision, and, as at the original operation it had been difficult to inspect this area behind the left mastoid where the swelling had originated, the bone was carefully examined.

A small round hole, penetrating the entire thickness of the skull and leading to the extradural space in the posterior fossa, was seen—confirming the X-ray finding. No communication was found to exist with the mastoid air-cells, however, and the conclusion was that this had become obliterated. This wound was closed with drainage. The scalp had firmly united to the vault of the skull over the entire raised area within fourteen days, and the patient left hospital, extremely pleased with his altered appearance (*Fig.* 434), twenty-three days after operation.

COMMENTARY

Trotter has pointed out that the pericranium, or external periosteum of the skull in adults, is of low osteogenetic power, and that its detachment from the skull over large areas, if not accompanied by sepsis, produces no effect on the nutrition of the bones, which comes almost exclusively from the diploe. In the case described detachment of the pericranium was almost complete over the vault of the skull, and was attended by no necrosis of the stripped bones. The pericranium becomes less dense as it approaches the temporal region, and at the same time considerably more adherent to the bone than it is over the vault of the skull, which accounts for the limiting of the 'air tumour' to the vault in this particular case.

FIG. 435.—View, taken with the Potter-Bucky diaphragm, of the left mastoid region, the X-ray tube being tilted and the left mastoid lying next to the plate. An extraordinary development of abnormal mastoid air-cells has occurred, causing a sponge-like nature of the occipital bone in the region of its synostosis with the mastoid. Several particularly large accessory air-cells are visible. A small hole marked X in the region of the supra-meatal triangle suggests the original sinus resulting from mastoiditis which permitted the air tumour to commence.

Undoubtedly the therapeutic puncture carried out by the village leech must have perforated the thin sponge-like bone of the abnormally developed mastoid air-cells, and produced a large opening which not only led from the cells to the subpericranial area of the cranium superficially, but also to the extradural area of the posterior cranial fossa (*Fig.* 435). Whilst extracranial variations in the air-pressure under the scalp would not cause pressure symptoms, increase of extradural pressure in the posterior fossa apparently caused the nausea and vomiting from which the patient occasionally suffered.

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RECURRENT INTUSSUSCEPTION OF THE JEJUNUM

By WILLIAM GISSANE

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BENIGN tumours of the small intestine are not common; Rankin and Newell[1] report that up to 1933 only 35 had been seen at the Mayo Clinic. It is well known that such tumours may start off an intussusception in an adult. The following case is an example of intussusception of the jejunum due to a submucous lipoma. A study of the history of the patient and of the specimen leaves little doubt that this benign tumour has been the cause of repeated intussusceptions over a period of two years. The frequency of the attacks had so undermined the patient's general health that he had lost two stones in weight. He had sought relief of his trouble at many hospitals, and in spite of many clinical and radiological examinations the condition had not been diagnosed. He was admitted to St. James's Hospital during his worst attack of intestinal obstruction. Now that we know the answer to his previous symptoms, we do not think the correct diagnosis in these cases is difficult!

CASE REPORT

HISTORY.—Male, aged 55, a blacksmith. Complained of severe pain situated around the umbilicus. The pain had come on suddenly seven hours previously, and there had been no remission of its severity. He had vomited five times. For two years he had suffered from attacks of abdominal pain, but on only two previous occasions had the pain been as severe as the present attack. Each of the severe attacks had lasted for two days. The less severe attacks lasted for an hour or less. In recent months he had attacks of abdominal pain as frequently as every second day. He had noticed blood in his stool after these attacks on several occasions.

ON EXAMINATION.—Pulse 112, temperature 97°. The patient was obviously in great pain and restless. The abdomen showed a moderate central distension, it was tender and rigid on palpation, but no definite tumour was palpable. Rectal examination was normal.

FIRST OPERATION.—Immediate operation was decided on, and through a right paramedian incision the receiving tube of an intussusception presented as a very dilated and extremely tense piece of bowel, forming a sausage-shaped tumour 18 in. in length. This bowel was blue in colour, and its serosal coat was split in many places. The entering bowel was collapsed. The intussusception was reduced by gently pulling on the entering bowel. The intussusception was so tense that there was no possibility of reducing it by accepted methods. After reduction the bowel was so thickened with œdema that it was impossible, then, to make a diagnosis of any cause within the lumen of the bowel for the intussusception. The intussusception was situated about four feet from the duodeno-jejunal junction, and after reduction the implicated bowel measured about 3 ft. The mesentery of this loop was very long and thick, with firm fat and a great deal of fibrosis. It seemed obvious from the history and the condition of the mesentery of the bowel that this was a case of recurrent intussusception.

During the following four weeks the patient was kept on an easily digestible diet and had no further attacks.

SECOND OPERATION.—At the end of the four weeks a second operation was performed. Now the œdematous condition of the bowel had subsided and its clinical pathology was demonstrable. About four feet from the duodeno-jejunal junction was a very obvious stricture. Six inches below this a soft, somewhat mobile tumour was palpable through the bowel wall. Eighteen inches below this again was another stricture, and following this rather thickened and indurated bowel for a few inches. The lumen of the bowel was now normal,

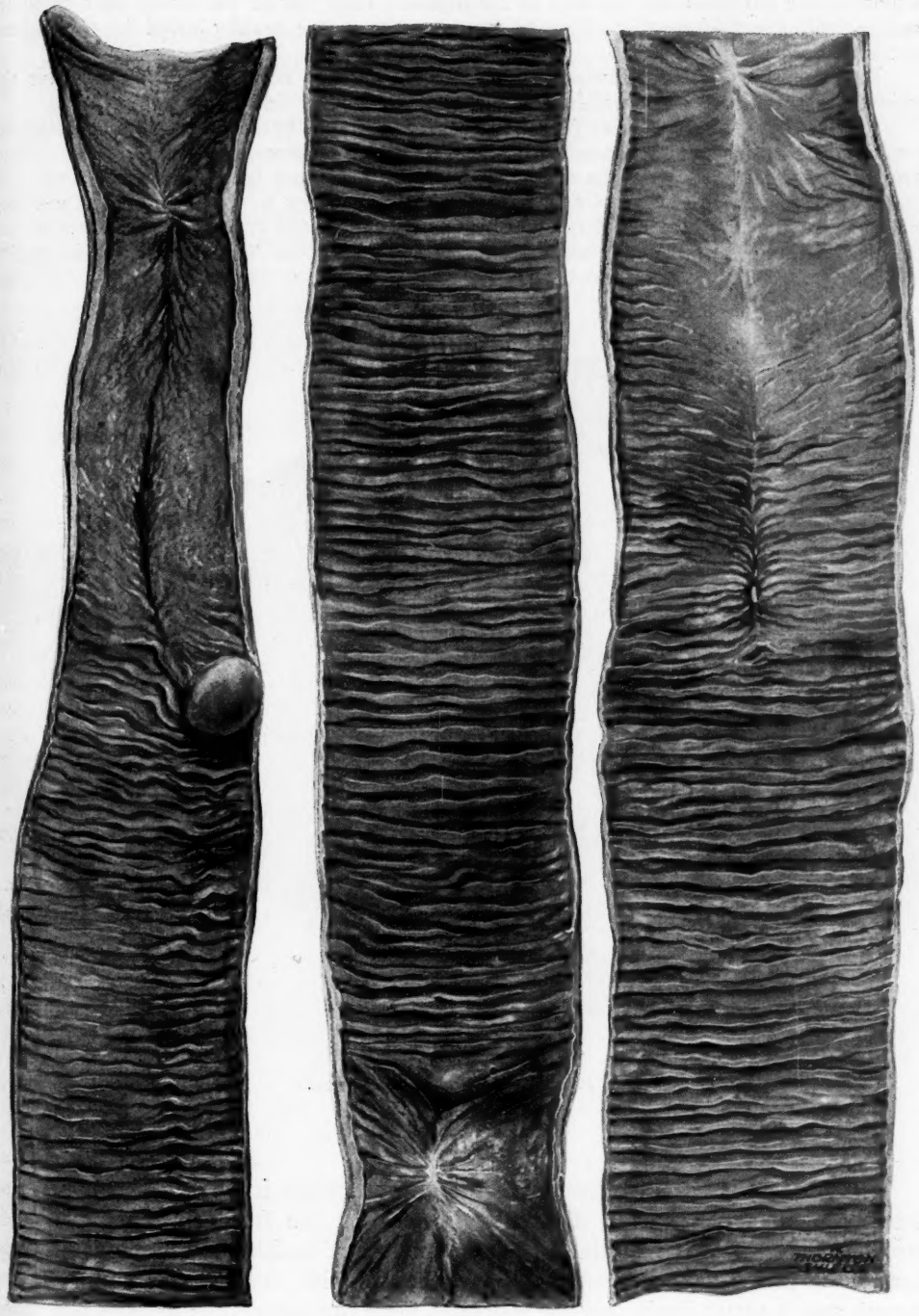

FIG. 436.—The intra-lumen appearance of the specimen, showing the proximal stricture, lipoma, and distal stricture, followed by an area of indurated bowel. The acute ulcers referred to in the text are not shown. Owing to its length the specimen has been drawn in three sections; the top of the second strip should be joined to the bottom of the first, and the top of the third to the bottom of the second, to reconstruct its continuity.

except for the strictures and the area of induration. Four feet of the bowel were resected, together with the thickened and fibrosed mesentery, to secure healthy bowel for the end-to-end anastomosis.

SUBSEQUENT PROGRESS.—Recovery was uneventful, and now twelve months later the patient has regained his lost weight and says that he "never felt fitter".

PATHOLOGY.—The specimen (*Fig.* 436) has been drawn by Mr. Thornton Shiells, who has divided his picture in sections to show clearly the condition from the mucosal surface. The size of the tumour and the strictures with the indurated bowel are well shown. In the fresh specimen two acute ulcers were clearly seen. They were situated about eighteen inches apart, the proximal one large and occupying almost the entire circumference of the bowel, and the distal one very much smaller. The submucous lipoma is shown in section in *Fig.* 437.

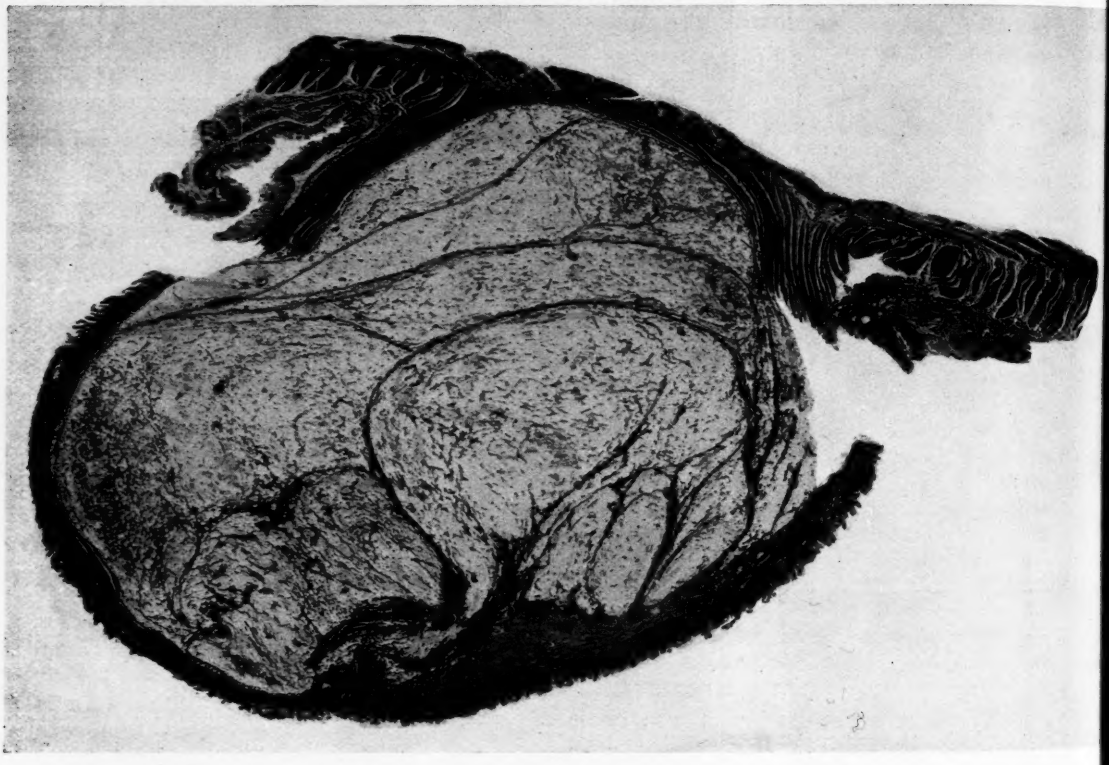

Fig. 437.—Section of the lipoma.

COMMENTARY

Of interest is the distribution of the two strictures in the specimen, with an intervening eighteen inches of healthy bowel. In the fresh specimen we noted two acute ulcers, also separated by eighteen inches of healthy bowel. It is probable that these ulcers were caused by an interference with the vascular supply of the bowel, and it seems likely that the strictures were the end-results of such ulceration caused in this way during previous intussusceptions.

Regarding the distribution of the strictures, it is suggested, on the evidence of this specimen, that the most vulnerable parts of an intussusception are its apex and the junction of the returning and ensheathing layers: the apex, because its

blood-supply suffers most from strangulation; the junction of the returning and ensheathing layers, because here the finer vessels are kinked and pressed upon very much in the same manner as the strangled bowel is pressed upon by the neck of a hernial sac. It will be recalled that the loop of bowel involved in this intussusception measured approximately 3 ft. If the intussusception is reconstructed it will be seen that the "most vulnerable points" will be eighteen inches apart, and this fits our theory very nicely. We would add that in measuring the length of bowel involved in the intussusception we have excluded the ensheathing tube of bowel. Although we noted that the serosal coat of this segment of bowel was split in places, the vascular mesentery to this segment is obstructed only at its junction with the returning tube of the intussusception.

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LATENT CARCINOMA OF THE PROSTATE

By D. McGAVIN

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One of the most interesting aspects of carcinoma of the prostate is the manner in which it may remain unsuspected by the clinician until a late stage in its course, quite commonly till the post-mortem, and occasionally even until the histological examination of the material so obtained.

Classification.—Such unsuspected carcinomata fall into three groups: (I) The first comprises those giving rise to no symptoms during life, their discovery being incidental to routine post-mortem examination. (II) In the second group are the growths found during treatment carried out on a diagnosis of benign enlargement. (III) The third group consists of those cases in which the more or less misleading nature of the symptoms has not led to suspicion of prostatic disease until a late stage in its course.

I. SYMPTOMLESS GROWTHS FOUND POST MORTEM

In 1934 Muir reported that in a series of 54 autopsies on men over the age of sixty he had found unsuspected carcinoma in 13 per cent. In those over seventy it was present in 23 per cent of cases.

Rich (1935), in 252 autopsies on unselected males over the age of fifty, found true and frank carcinoma in 41 cases (14 per cent). The foci were often small, but he considered the malignancy to be definite, with a tendency to early invasion of the prostatic capsule.

Moore, also in 1935, examined 262 prostates from men between the ages of forty-one and ninety. There was no carcinoma in men under forty-four. In the decade 41–50, 17 per cent of the prostates contained carcinomata; for the ages 51–60, the finding was 14 per cent; for 61–70, 23 per cent; for 71–80, 21 per cent; and lastly for 81–90, it reached 29 per cent. In the same series the proportion of prostates showing benign enlargement was, over the age of fifty-one, almost three times as high in each decade as the proportion of cases of carcinoma. The malignant change was often multicentric.

These figures show a considerable agreement between the findings of the different writers, and indicate that carcinomatous change is commoner than is generally known, and also that the incidence of such change increases with rising age. Beyond this the existence of the group is of little practical importance, since, by definition, the growths give rise to no disability and the patients die, mostly at a ripe age, from some independent cause.

II. GROWTHS FOUND DURING TREATMENT FOR BENIGN HYPERTROPHY

This group of prostatic growths first received general attention when Albarran (1900) claimed to have found 14 unsuspected carcinomata in 100 cases thought to

have been simple hypertrophy. Many people did not agree with his findings, as they were not prepared to accept his standards of suspected carcinomatous change. Clay Shaw (1924), after finding a case with two small and separate carcinomatous foci in the hypertrophied lateral lobe of a prostate, examined or re-examined over 1000 specimens of simple prostatic hypertrophy at the Johns Hopkins Hospital, and found only 2 cases of carcinoma amongst them. This gives two extreme estimates. One places the incidence of unsuspected carcinoma in prostates operated upon for benign hypertrophy as high as 14 per cent, a figure that few clinicians or morbid histologists would not consider too high, while the other gives an incidence of not more than 0·02 per cent. Additional evidence is required.

During the years 1921–35 inclusive, 388 prostatectomies were performed at St. Bartholomew's Hospital. Of these prostates 20 were carcinomatous. The case notes of 7 of these stated explicitly that the diagnosis had not been made before operation, suspicion being aroused by the difficulty of removing parts of the gland, which was firmly adherent to the neighbouring structures, particularly to the seminal vesicles. The notes of 3 other patients indicated from their wording that no diagnosis of malignancy had been made before prostatectomy was undertaken. In the remaining 10, carcinoma had been diagnosed or suspected before operation. Thus of 378 prostatectomies performed on a diagnosis of benign hypertrophy, 10 cases proved to be carcinomata. This gives an incidence of 2·6 per cent. The figure might have been a little higher if routine serial sections had been made of all prostates removed, but this is impossible to estimate.

It will be noted that this incidence refers to carcinomata occurring in prostates that are the seat of benign hypertrophy, and does not confine itself to growths having their origin in hypertrophied tissue. Moore (1935) and Barringer have shown that approximately three-quarters of the carcinomata arise in the posterior lobe, which is uncommonly the seat of benign hypertrophy, being so affected in only 6 per cent of the cases examined by Riches and Muir (1932). From this origin the growths may spread around areas of innocent enlargement or invade them, so making enucleation difficult. Malignant change arising in hypertrophied tissue is probably uncommon (Moore, 1935).

Is there any method of distinguishing these cases before operation? There is no certain method; but some features may lead one to take particular care in the search for a carcinomatous nodule. Pain, as pointed out by Young, is much commoner with a malignant than with an innocent prostate. Of 100 cases of carcinoma of the prostate collected from the records of St. Bartholomew's Hospital from the beginning of 1921 to the end of 1936, 16 per cent complained of pain as the initial symptom and 65 per cent felt it at some stage before coming to hospital. Acute retention also should make one suspicious of the presence of a growth. It occurred at some stage in the histories of 43 per cent of these 100 cases and was the initial complaint of 5 per cent. In his series Bumpus (1926) found it was the first symptom in 3·7 per cent, but Barringer (1931) reported it as the first abnormality noticed in as many as 16 per cent of cases.

Any of the classical signs of carcinoma may be absent. In these 100 patients hardness, the estimation of which depends so much on the individual clinician, was absent in 2 of the 93 cases in which the finding was recorded. Irregularity was absent in 5 of 54 cases, and there was no enlargement in 5 out of 96. Fixity, being a sign of extra-prostatic spread, need not be discussed.

Cystoscopy may lead to the revision of a diagnosis of innocent enlargement. Forty-two of these cases were cystoscoped, and in every case some abnormality, not necessarily malignant, was to be seen. An ulcerating mass was present in 8, while 2 more had nodules of growth below an intact vesical mucosa. Thirty-nine had some degree of intravesical projection of the prostate, but in most cases without any decisive evidence that it was malignant. Œdema of the mucous membrane overlying the prostate, or difficulty in passing an instrument through the posterior urethra, giving a sensation of being gripped by fibrous tissue, may be present to raise suspicion of a growth.

When the gland contains a suspicious area, accessory methods of diagnosis may be useful. Apart from a radiograph to show the presence of possible prostatic calculi or carcinomatous deposits in the lumbar vertebræ, pelvis, or upper ends of the femora, there are two methods to be considered. Biopsy by prostatic puncture from the perineum as performed by Ferguson (1930), and used as a routine in the examination of all cases of senile prostatic disease by Barringer (1931, 1935), gives material for smears in 80 per cent of the cases on which it is carried out. From a small series of punctures I can confirm their statement that, with ordinary care, it gives rise to no complications. A little practice in the technique is required to obtain satisfactory smears, but both workers quoted show excellent photographs of biopsy material obtained in this way. In 1930 Mulholland claimed that there were specific cells, clumps of rather large cells with acidophil nuclei, to be found in the secretion obtained by massaging the carcinomatous prostate, and stated that he had found them in 23 of 30 cases of proved carcinoma and had been unable to discover them in any of a large number of control smears. This paper has received singularly little attention, either in confirmation or refutation.

It is hardly necessary to stress the importance of histological examination of all material obtained by perurethral resection of the prostate. It is conceivable that a growth starting in the posterior area of the gland and not having infiltrated extensively forward might not have any of its substance included in the pieces removed by perurethral methods, but such a growth would be in a situation that would make it apparent on the rectal examination that would necessarily have been performed when making the diagnosis of prostatic disease.

It may be objected that there is little importance in making a pre-operative diagnosis of carcinoma, but with this I cannot agree. When Young (1935) by his radical prostatectomy can obtain 16 cures from 33 patients who had left hospital five years or more before the time of writing, and can reduce his operative mortality to 4·8 per cent, there is reason to make every effort to diagnose malignancy in as early a stage as possible in order to increase the small proportion of cases suitable for such a procedure, whether it be done by the perineal route devised by Young himself or by the suprapubic route described by Morson (1924, 1926).

Further, if the diagnosis of carcinoma be made before operation and the case is unsuitable for radical excision, then a prostatectomy of the ordinary type is not indicated. In the 21 such prostatectomies performed in St. Bartholomew's Hospital on carcinomatous prostates, there was an operative mortality of 5 (23·7 per cent), and of the survivors only 2 lived for four years after operation, though another is still alive at twenty months. It is true that one is alive and well fifteen years later, but cures obtained by this method must be rare and largely fortuitous. It is also true that obstruction is relieved by this operation, but this end can be achieved more

easily and with less risk by perurethral resection, or, when this is contra-indicated, by cystostomy. In some cases the growth may be stimulated into greater activity by the increased blood-supply and the release from the pressure of surrounding

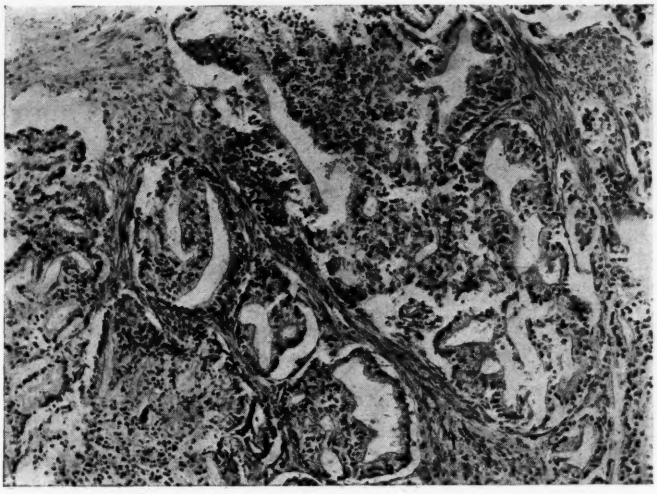

FIG. 438.—Section from a carcinomatous prostate removed at operation. To show a differentiated type of growth. (× 65.)

cells following partial enucleation. *Fig.* 438 shows a growth with a tendency to the formation of definite acini, which was removed at operation for what had been diagnosed as senile hypertrophy. The patient died eight days later, when the growth remaining in the prostatic bed had a much more malignant appearance (*Fig.* 439).

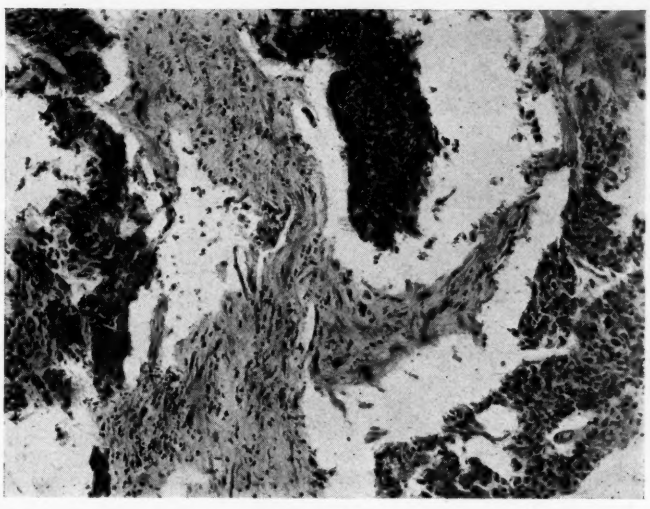

FIG. 439.—Post-mortem section from the prostatic bed of the same case, eight days later. (× 65.)

Although that part of the carcinoma may possibly have been in this condition before the operation, I do not think it probable, particularly as the metastases showed as strong a tendency as the primary growth to the formation of acini (*Figs.* 440, 441).

For these reasons—the high mortality of the ordinary type of prostatectomy when performed on malignant cases; the necessity of increasing as far as possible the number of patients suitable for radical excision; and the possibility of

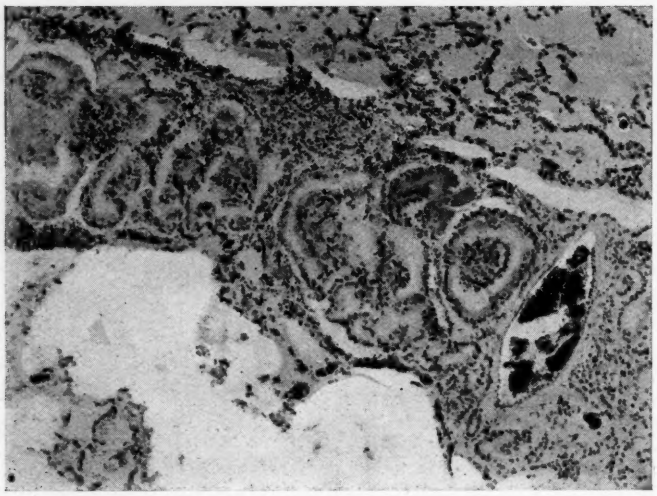

FIG. 440.—Lung metastasis from the same case. (× 65.)

increasing the rate of growth or disseminating it more rapidly—it appears to be desirable that a distinction between benign enlargement and carcinoma be made before operation whenever possible.

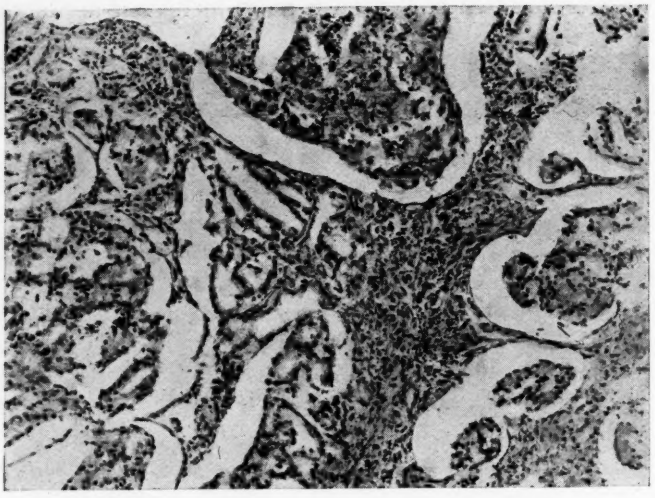

FIG. 441.—Metastasis in a lymph-gland from the same case. (× 65.)

III. GROWTHS WITH MISLEADING SYMPTOMS

In this group are the cases in which the nature of the symptoms, commonly due to metastases, do not lead the examiner to suspect the existence of prostatic disease until some time has elapsed after the patient has first presented himself for

treatment. It covers a wide range of cases, from those in which the diagnosis is virtually impossible, to those implying serious omissions either in the examination of the patient or in the consideration of the possible causes of his complaints.

Amongst the 100 cases investigated there were 2 who had not suffered from urinary symptoms at any stage. One man had jaundice and epigastric pain for two months before coming to hospital. His liver was large, nodular, and tender, and his prostate was enlarged, hard, and irregular. His urine was sterile. At autopsy five days later there was found an adenocarcinoma of the prostate and a liver filled with metastases up to 2 in. in diameter. There were deposits in the glands in the hilum of the liver and in the para-aortic group, but not in those along the internal iliac vessels. The second patient complained of pain in his back coming on two months after a fall, and he had an angular kyphosis in his upper lumbar region which led to a preliminary diagnosis of Kümmell's disease. X rays

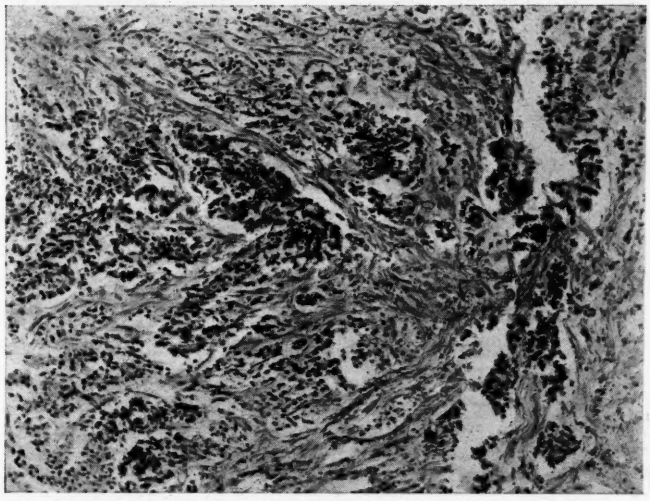

FIG. 442.—Primary growth from a case with wide spread and profound anæmia. (× 65.)

showed collapse of the twelfth thoracic and first lumbar vertebral bodies, with no other bone lesions in the spine or pelvis. Rectal examination then revealed a prostate that was hard on one side, extending out into the pelvis, and fixed.

In other cases micturition symptoms were late and trivial, and in several more urinary complaints were mild though not particularly late. One of these had noticed some increased frequency of micturition for a year, but came to hospital complaining of generalized pains, extreme weakness, pallor, wasting, shortness of breath, and swelling of the ankles. His prostate was fixed and infiltrating. There were deposits spread widely through the skeleton, in the bone-marrow, and under the pleuræ. On examination of the blood by Dr. R. Bodley Scott there were only 860,000 red blood-corpuscles per c.mm. and 16 per cent hæmoglobin. Leucopenia was present to 3800 per c.mm., with marked immaturity of the granular cells. Nucleated red cells were present. Also, in the films made after sternal puncture he was able to recognize carcinoma cells. (*Figs.* 442–444.)

Pain may be felt in the back (14 cases), as sciatica (4 cases, of which 3 also had pain in the back), in the thigh (1 case), or rectum (1 case). Pain in the hypogastrium,

perineum, penis, iliac fossæ, on micturition, or as renal colic from partial occlusion of the lower end of a ureter, may be considered as so likely to lead to an examination of the urinary system as to need no further mention.

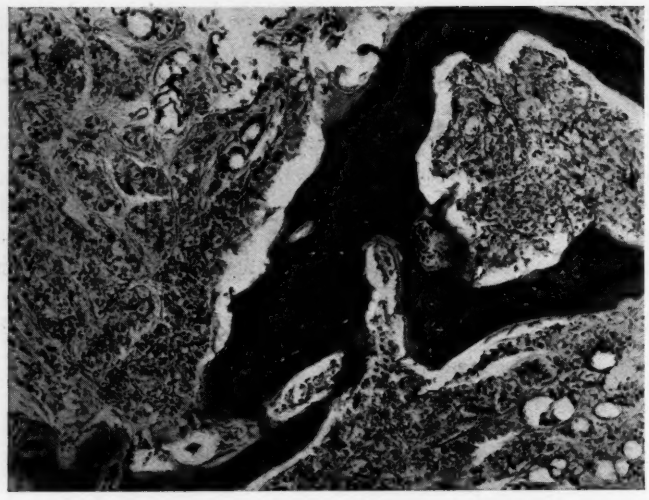

FIG. 443.—Bone metastasis from the same case as *Fig.* 442. (× 65.)

Amongst the initial symptoms were one complaint of diplopia caused by a skull metastasis, one of a swollen leg due to a mass of growth in the iliac gland, and three of constipation. This last is an interesting symptom. Each of the three patients who

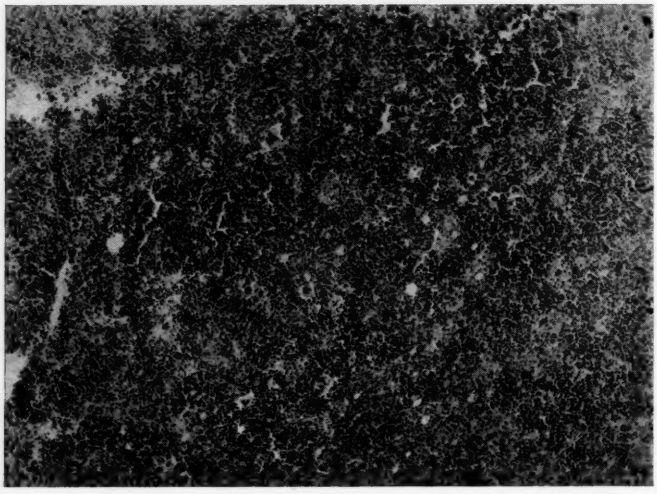

FIG. 444.—Bone-marrow from the same case as *Figs.* 442 and 443. To show islands of carcinoma cells. (× 65.)

noticed it as the first abnormality had a large, fixed prostate, and in each the development of micturition symptoms was long delayed. Five more patients noticed it as a subsequent complaint. One man was treated by his doctor for piles, but as this

did not satisfy him he put himself under the care of another practitioner who carried out a rectal examination and made the correct diagnosis. Kickham (1936) reported 4 cases of prostatic carcinoma resembling a primary growth of the rectum occurring in one hospital during the course of three years. The predominant symptoms were severe constipation, tenesmus, and the passage of mucus. In one case there was rectal bleeding. Barringer (1931) found that 8 of his 280 cases had no urinary symptoms at any time. One of these complained of persistent diarrhœa, one of rectal bleeding, the true cause of which was only diagnosed after excision of piles had failed to cure the symptom, and a third was submitted to colostomy and the excision of a supposed rectal carcinoma. A fourth had fæcal incontinence caused by invasion of the anal sphincter, so that four of the eight had leading bowel symptoms.

The fifth of Barringer's cases without micturition symptoms had for three years suffered from curved erections due to invasion of the corpora cavernosa, thus to some extent resembling the case of priapism reported by Frontz and Alyea and quoted by Willis (1934). The remaining three had operations performed on various metastases. Willis also quotes Lundsgaard's case, in which a large cervical mass was partly excised, and in which the prostate, macroscopically normal at autopsy, was found on section to contain the primary carcinoma. Of the series I have collected no patient had noticed a mass as the first complaint, and only four had found one during the subsequent course. In each case the swelling was iliac or inguinal, where it would naturally lead to an investigation of the rectum and urogenital system when the lower limbs were seen to be healthy.

That a metastasis in bone may cause the predominant or even the only symptoms is well known, and the anæmia to which such deposits can give rise when widespread has been illustrated by the case already quoted. Of the 27 cases from this 100 who had blood-counts carried out, 11 had no evidence of metastasis or gross local invasion and had average readings of 5,400,000 red blood-corpuscles per c.mm. and 90 per cent hæmoglobin; while the remaining 16 with metastasis or gross invasion had an average of 3,700,000 red blood-corpuscles per c.mm. and 67 per cent hæmoglobin.

One man with pain in his back was treated for a year in the Out-patient Department before the onset of urinary symptoms led to the diagnosis of prostatic carcinoma, and another was so treated for six months. Unexplained pain in the back or legs of men over the age of forty-five quite deserves a rectal and an X-ray examination before treatment is instituted for arthritis of the spine.

In 8 per cent of the 100 cases the initial symptom indicated extra-prostatic spread or metastasis. In 56 per cent the history or ordinary clinical examination, not including cystoscopy, gave evidence of local or distant spread beyond the prostatic capsule at the time of the first attendance at hospital. This serves to show that the majority of cases of prostatic carcinoma have a moderately long period during which they remain quiescent and in which more than half the number extend beyond the limits of the gland.

CONCLUSIONS

1. Latent carcinomata of the prostate fall into three classes: (1) Those that are symptomless and are only discovered on routine post-mortem examination; (2) Those that are first suspected during operation carried out on a diagnosis of benign

enlargement; and (3) Those in which the symptoms do not lead to suspicion of prostatic disease until a late stage.

2. The incidence of carcinoma discovered at operation for benign hypertrophy was 2·6 per cent of 378 cases.

3. There are definite reasons for attempting to diagnose as many of the second type of case as possible before submitting them to prostatectomy.

I wish to thank the Staff of St. Bartholomew's Hospital for allowing me to make use of the cases under their care, and particularly Professor Hadfield for facilities in examining sections and in taking microphotographs.

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INTERLOCKED ARTICULAR PROCESSES COMPLICATING FRACTURE-DISLOCATION OF THE SPINE

A SURVEY OF SOME RECENT CASES TREATED BY OPEN OPERATION

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FOREWORD

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THE working conditions of the average pitman in the collieries of the North of England differ from those in most other parts of the country in that the seams are low, and it is not unusual to find that a man has to hew coal in a space eighteen inches high. This necessitates his lying in varying attitudes of flexion. The roof above him may give way and some quantity of stone or coal fall on to his back or shoulders, forcing him into acute flexion, and producing the several forms of compression fractures of the spine, the dorsi-lumbar variety predominating.

In the course of the years 1935–36 there were 97 cases of compression fractures of the spine admitted to the male ward of the Orthopædic Department of the Royal Victoria Infirmary, and they were treated by reduction and plaster in hyperextension on the lines which are now recognized as standardized for this type of lesion, correction of deformity being confirmed by lateral and antero-posterior radiographs. Of this number, 9 cases were suffering on admission from what appeared to be definite cord or cauda equina complications. Of these nine cases two are typical of the described condition.

On October 24, 1935, the first of this series of cases was admitted, and after an attempt at reduction had been carried out, radiography demonstrated the persistence of an obvious deformity, a deformity which could not mechanically be overcome by manipulative methods. Mr. Munro, who was then the house surgeon, appreciated the state immediately, and what seemed the obvious operation was carried out four days later. The actual procedure is described, and one was impressed with the technical ease with which it can be performed. Following the removal of the bony obstruction, when hyperextension of the spine was effected, it was very satisfactory to watch the completion of reduction take place under the direct view of the eye.

Two similar cases, not reported, have been seen during the past year, but were of such long standing that operative interference could not be of any avail. The true nature of the condition had not been appreciated early enough.

It is our opinion that there are a number of such cases, and that if the diagnosis be immediate and the treatment adequate they are given every opportunity of maximum recovery.

GENERAL DISCUSSION

So far as I am aware, the only published material on this subject is contained in a short account of the operative technique in Lorenz Böhler's *Treatment of Fractures*.[1] No case reports have, as yet, appeared. I venture to think that this complication occurs with comparative frequency in cases of fracture-dislocation of the spine with paraplegia, and that it goes unrecognized.

Fig. 445 shows the lateral view of just such a case. Whilst in general practice, I was called to the local colliery to see this man, who had been involved in a fall of stone. He had a complete paraplegia, and a gross kyphos was present in the lower dorsal region. On my return to hospital work some months later,

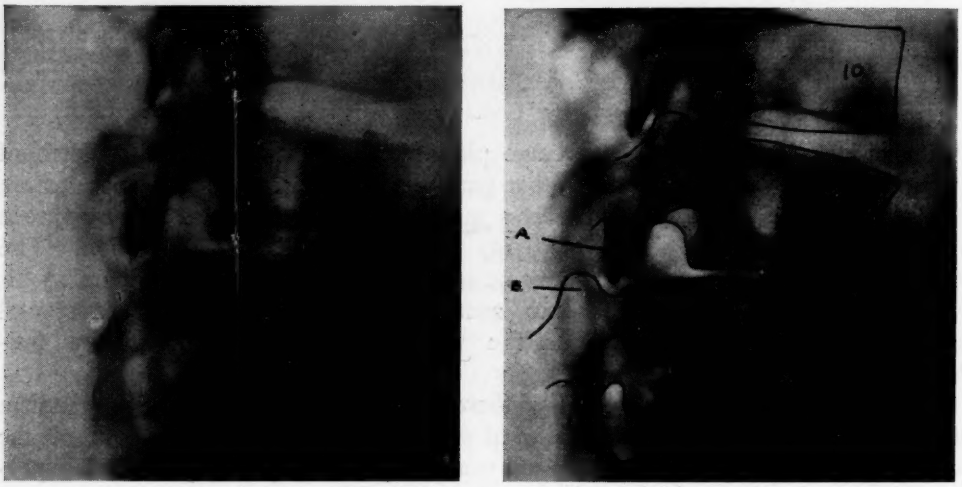

FIG. 445.—Lateral radiograph and rough tracing showing fracture-dislocation between the eleventh and twelfth thoracic vertebræ, complicated by transposition of the intact articular processes A and B. The clear area in front of A marks the normal position of the process B.

I was able to confirm my suspicion that this was a case with transposition of the articular processes. The patient succumbed to ascending pyelonephritis some six weeks after the accident. Reduction had been incomplete, and there had been no change in the paraplegia.

Fracture-dislocation of the spine with transposition of the articular processes is produced by indirect violence, and occurs most commonly in the lumbar region. The force, applied to the shoulders and upper dorsal area, is of such a degree as to cause disruption of the interspinous ligament, followed by a carrying forwards of the upper dislocating vertebra over its subjacent neighbour. Owing to the extreme flexion the articular facets are separated, and the position of the processes transposed without fracture occurring. The inferior processes finally come to rest upon the laminæ of the subjacent vertebra, and in front of the corresponding superior processes. Compression fracture of the vertebral body below the dislocation is usually also present.

Paraplegia may be produced in these cases in several ways:—

1. So-called 'spinal shock' or 'concussion'.

2. Œdema of the cord and surrounding tissue, or by the pressure of extravasated blood.

3. Hæmatomyelia.

4. Attenuation of the cord. The cord is not directly crushed in these cases, since the intact processes prevent it. Tension occurs, however, since the cord is stretched between the laminæ of the vertebra above and the posterior lip of the vertebral body below, so that rupture, partial or complete, may occur due to attenuation between these two points. This can be easily demonstrated by means of skeleton vertebræ and a length of rubber tubing.

5. Finally, it must be emphasized that delay in reduction may render a recoverable paraplegia permanent.

It will be evident from the above remarks that any treatment—manipulative, longitudinal traction, or hyperextension—which tends to increase tension on the attenuated spinal contents is contra-indicated. The prompt operative removal of one or both of the superior articular processes of the vertebra below the dislocation does, however, offer a means of reduction without this disadvantage, and with minimal disturbance of the patient.

Böhler[2] illustrates a manipulative technique, by flexion and longitudinal traction followed by hyperextension, for use in these cases. Nevertheless, it would appear that, for the reasons given above, open operation is the better procedure.

TREATMENT

Management of a Case.—On admission frontal and lateral radiographs should be taken, and the patient catheterized with as little disturbance as possible. Shock should be dealt with in the usual way: 10 c.c. of 1 per cent novocain injected over the kyphos has often a remarkable effect in allaying shock, owing to the relief of pain and muscle spasm. A sedative, opoidine gr. $\frac{1}{3}$, should be given. The skin over the kyphos and over the femoral condyles should be prepared for operation. When sufficiently recovered, the patient is transferred to the operating table, lying flat and face downwards. A rubber bathing cap is put on his head, and spats, fastened to a rope and pulley-block, are secured on his feet. If possible a portable X-ray machine should be available.

Operation.—Having localized the site of fracture, the area is painted broadly with tinc. iodine, and sterile towels are suitably arranged. The area is infiltrated with 2 per cent novocain. A short, slightly curved incision, about 3 in. in length, is made over the kyphos. The tips of the spinous processes are displayed, and the muscles separated off on each side. There is usually a considerable amount of muscle tearing present. Extravasated blood should be cleared away, and bleeding points secured, and oozing may be controlled by hot saline packs.

The spinous processes of the two involved vertebræ are cleared, and if necessary the upper one is removed at its base to allow easier access to the two superior articular facets, which can then be easily recognized as small glistening surfaces in the depths of the wound. A process is removed on one side. An assistant now gently attempts reduction by hyperextension from the pulley-block. Should this not occur the opposite process is also removed, and hyperextension again applied, when reduction will surely follow—the vertebræ can be seen to glide over each other in the open wound. The amount of traction required is just sufficient to raise the pubes about a hand's breadth from the table.

Böhler[3] states that in most cases it is only necessary to remove a portion of the facet on each side—namely, sufficient of the anterior part of each superior process—to expose the inferior processes lying in front—this point is very well illustrated diagrammatically in his article. This modification has the advantage of preserving the major part of each process, and thus helps to maintain reduction, and subsequently enhances the stability of the spine. The muscles are drawn together with a few catgut sutures, and the skin edges closed by interrupted silkworm. Spirit dressings, evenly spread, are covered by a thin layer of cotton-wool, which should be sealed to the skin by means of collodion. Radiographs are now taken.

Having smeared vaseline on the skin, and protected the dressing with a piece of jaconet, a plaster bed is now made. Broad, 10-in. 'Cellona' bandages are excellent for this purpose. The bed should be rapidly dried, trimmed, and re-applied to the patient. Traction is released, and the patient rolled on to his back in the plaster bed, and transferred to the ward.

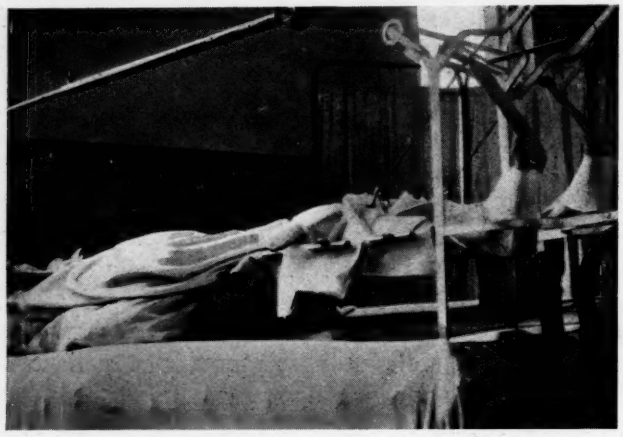

FIG. 446.—Photograph showing the method of slinging the patient, lying in a plaster bed. The legs are raised on modified Braun's splints, the feet suspended, and Kirschner wire skeletal traction is applied to the femora. The foot of the bed is raised eight inches. The bar of a Pearson's frame provides a hand grip above. The stirrups are here shown wrapped in bandage, which was only put on to prevent chafing during some minor adjustments; no dressings are normally required. This patient was able to raise himself out of his plaster, in hyperextension, on the third day after operation.

Putting up the Patient.—Each leg should be raised on a Braun's splint, and each forefoot slung, by means of Elastoplast, a 2-lb. weight, and a cord over a pulley. Skeletal traction to the femora should be obtained by means of Kirschner wires and stirrups, with a 15 to 20-lb. weight applied to each. The foot of the bed is raised about six or eight inches by blocks or steps. This arrangement prevents the development of paraplegic œdema, and does much to ward off pressure sores. A hand grip should be provided. For the care of the bladder Böhler advocates the indwelling catheter with twice daily irrigation, and urinary antiseptics by mouth. (*Fig.* 446.)

After-care.—After a few days, with the above arrangement, the patient should be able to lift himself, in hyperextension, right out of his plaster bed, thus allowing access to his back for nursing attention. Massage and electrical stimulation of paralysed muscles should be commenced early. Acute dilatation of the

stomach and paralytic ileus are, unfortunately, well-recognized complications of spinal injuries, and must be watched for.

Signs of recovery should be apparent within a few days, if the cord has not been irretrievably damaged. Should recovery ensue, then the patient is treated as an ordinary case, in a walking plaster in hyperextension.

CASE REPORTS

Before describing the first case it should be pointed out that we were not, at the time, fully conversant with Professor Böhler's technique. We were also somewhat hampered by lack of equipment. The course of treatment, therefore, is slightly different from the scheme suggested above. Comments on the difficulties we encountered are given in parenthesis.

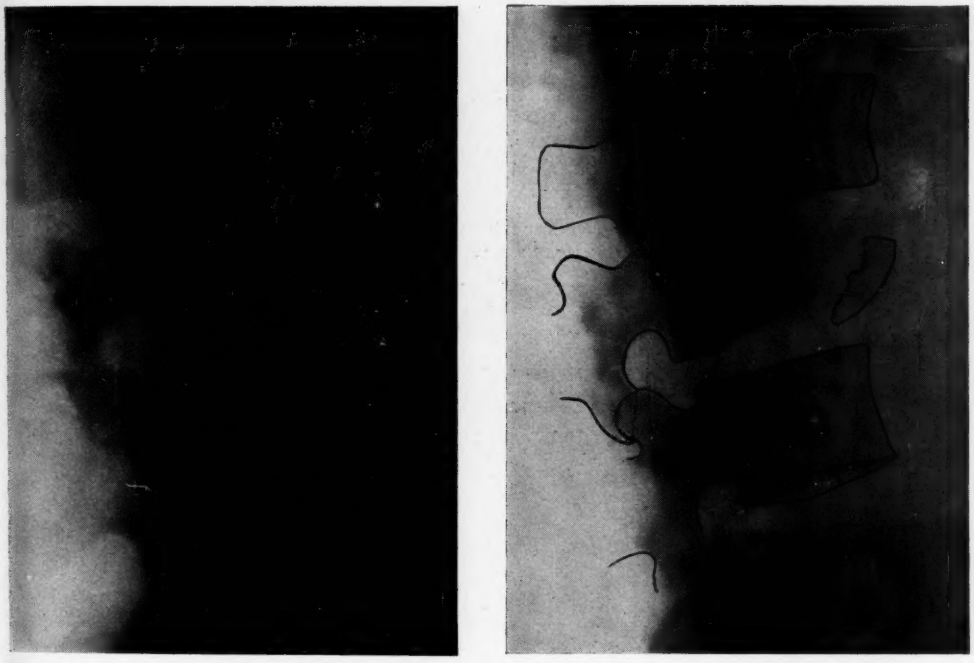

FIG. 447.—*Case* 1. Radiograph and tracing showing forward dislocation of the first lumbar on the second lumbar vertebra, with transposition of the intact articular processes. Compression fracture of the second lumbar vertebral body, and separation off of its anterior third, attached to the anterior longitudinal ligament.

Case 1.—J. T., coal miner, aged 28. Married. Admitted to the Royal Victoria Infirmary, Newcastle, in the evening, having been involved in a fall of stone an hour and a half previously.

ON ADMISSION (October 24, 1935).—Very shocked and cold. Loss of reflexes. Paraplegia. Hyperæsthetic zone midway between umbilicus and symphysis pubis. Kyphos present in upper lumbar region. Catheterized: urine clear.

X-RAY EXAMINATION.—Forward dislocation of the first lumbar vertebra, compression fracture of the second (*Fig.* 447).

TREATMENT.—

October 25, 1935.—Hyperextension from the feet. Local anæsthesia (2 per cent novocain). Plaster bed with skeletal traction—Hey-Groves's splints used, since Braun's splints were not available. X-ray examination: reduction incomplete, due to interlocked

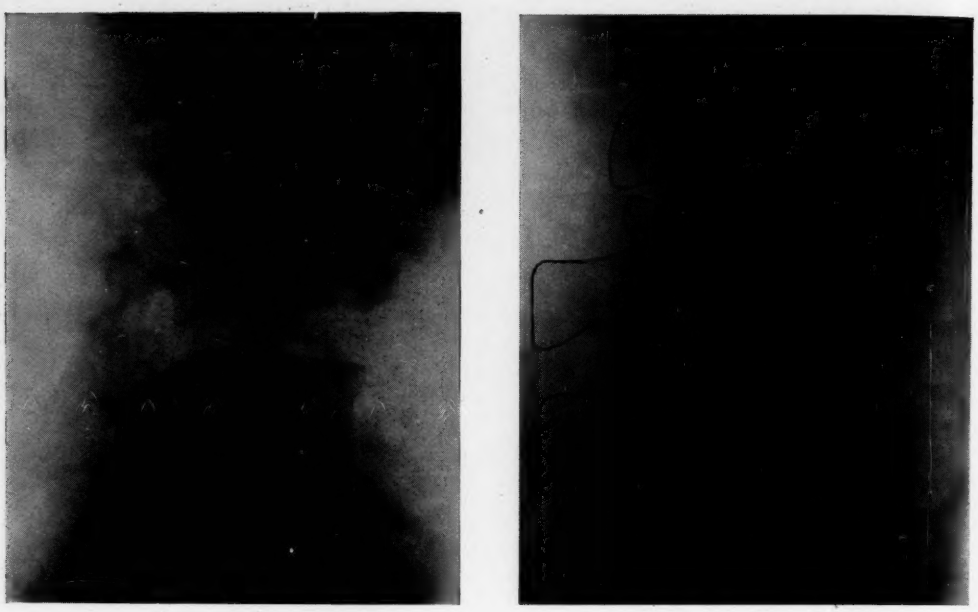

FIG. 448.—*Case* 1. Radiograph and tracing showing appearance after reduction had been attempted by hyperextension. Articular processes are still transposed. Anterior third of the second lumbar vertebral body is partially reduced.

FIG. 449.—*Case* 1. Radiograph and tracing after the superior articular processes of the second lumbar vertebra had been removed. Accurate anatomical reduction of both fracture and dislocation has been obtained.

articular processes (*Fig.* 448). [Had we recognized the true nature of the injury, this stage would have been omitted, and operation carried out instead.]

Operation (Mr. C. G. Irwin).—On October 29 the articular processes were removed as already described. No leak of cerebrospinal fluid. Anæsthesia: gas and oxygen, combined with local (2 per cent novocain with adrenaline). Radiograph shows accurate anatomical reduction (*Fig.* 449). [Delay of four days resulted in unhealthy skin, necessitating a large incision and skin flap. The general anæsthesia was unnecessary. The use of adrenaline with the novocain was a mistake in an area already somewhat ischæmic from pressure.]

SUBSEQUENT PROGRESS.—

November 1, 1935: Signs of returning sensation, extending as far as the mid-thigh region.

November 9, 1935: Patient again slung up by spats in order to make a new plaster bed, the old one not having hardened properly. Wound looks unhealthy—old pressure points look like sloughing. [The result of delay in treatment, the use of adrenaline, and the prolonged anæsthetic—from which it took the patient some little time to recover.]

November 17, 1935: Touch sensation to both knees. Deep sensation present in both calves, with tinglings on rubbing the shins. Feet still anæsthetic; no œdema. Motor power: can contract quadriceps, sartorius, hamstrings, and adductors in both legs. Sphincters are uncontrolled.

November 28, 1935: The wound flap had sloughed [outcome of delay in operating]. Skeletal traction removed. Catheter permanently tied in. Patient turned and nursed in the prone position, to allow healing of the wound.

During the following month the patient developed a gross cystitis, due to the difficulty of recatheterization, and required a suprapubic drainage. Sensation and motor power showed some slight improvement. Wound almost healed.

January 4, 1936: General condition good. Motor power much improved. Anæsthesia *in statu quo*. Radiograph shows very slight slipping forwards of the first lumbar vertebra, and slight recurrence of compression of the second lumbar vertebra. [This slight recurrence of the deformity was due to our inability to maintain continous fixation in hyperextension.]

February 17, 1936: Patient was fitted with a Pardot's shield, instructed how to carry out his bladder toilet, and sent home.

April 19, 1937: The patient was visited in his own home, where he has a modified wheel chair in which he can get about in a quite amazing manner. He is a regular attender at the local football matches and at the club. He makes mats between times. He is very cheerful, and apparently contented with his lot. Sensation has remained much as it was, extending to the knees. There is perineal anæsthesia. Motor power is markedly increased, and he can turn himself about with ease. Defæcation is spontaneous, and although he can sense when it is about to occur, the actual act is unconscious. The bladder is clean. There is one notable change: under the influence of emotion erection will occur, and he states that he has had several erotic dreams, accompanied by nocturnal emissions. Physiologically I can find no explanation for this phenomenon.

The back is somewhat bent forwards, but is firm and painless. There is little sign of the old sloughed area.

Case 2.—M. S., coal-miner, aged 21. Single. Admitted to the Royal Victoria Infirmary, Newcastle, in the evening, having been involved in a fall of stone two hours previously.

ON ADMISSION (April 26, 1936).—Kyphos present in upper lumbar region. Flaccid paralysis and anæsthesia below the waist. Catheterized: urine clear.

X-RAY EXAMINATION.—Fracture-dislocation between eleventh and twelfth thoracic vertebræ, with transposition of the intact articular processes (*Fig.* 450).

TREATMENT.—

April 27, 1936.—Hyperextension from the feet. Local anæsthesia. No effect (*Fig.* 451).

Operation (Mr. C. G. Irwin).—Local anæsthesia (2 per cent novocain). Small incision. Large hæmatoma evacuated. Superior articular facets of twelfth dorsal vertebra removed on both sides. Hyperextension produced good reduction. Plaster bed made. Radiography

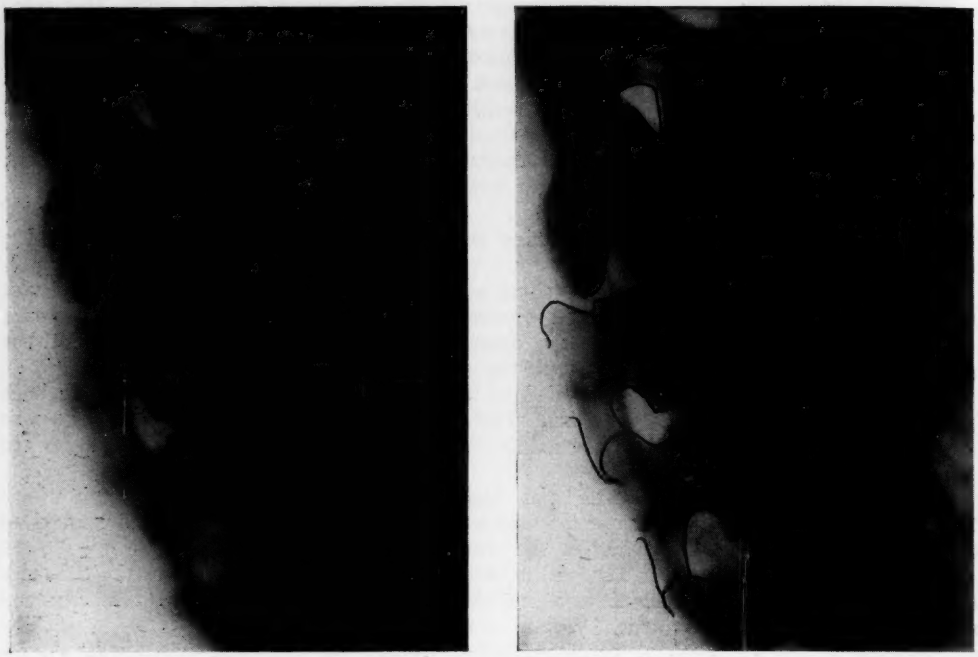

FIG. 450.—*Case* 2. Radiograph and tracing showing fracture-dislocation between the eleventh and twelfth dorsal vertebræ, with interlocked articular processes. Slight posterior compression of the eleventh vertebral body. Anterior compression of the twelfth vertebral body, and separation of a small anterior fragment. Slight anterior compression of the first lumbar vertebral body.

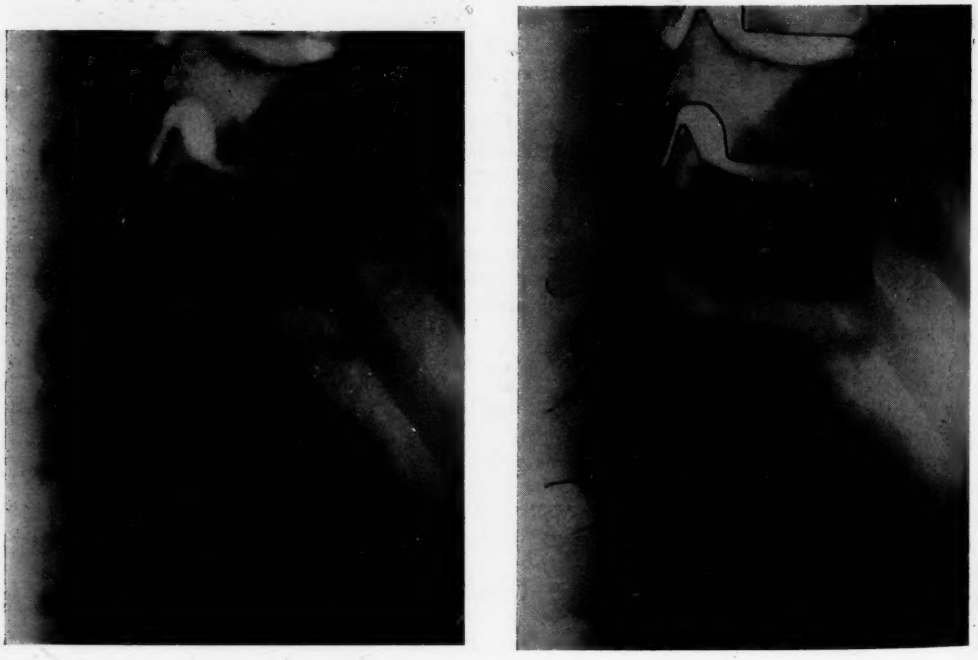

FIG. 451.—*Case* 2. Radiograph and tracing showing position after hyperextension. Dislocation not reduced, due to impaction of the articular processes. Kyphosis somewhat less.

showed dislocation well reduced (*Fig.* 452). Compression deformities persisted slightly, and would not reduce further. A leak of cerebrospinal fluid was present in this case.

SUBSEQUENT PROGRESS.—

April 28, 1936: Return of sensation to the mid-thigh region.

May 9, 1936: Suprapubic cystostomy performed—catheter method proved unsatisfactory.

FIG. 452.—*Case* 2. Radiograph and tracing after removal of the superior articular processes of the twelfth dorsal vertebra. The dislocation is reduced, and the continuity of the spinal canal restored. Compression fractures are partially reduced. Further reduction could not be obtained, and it leaves some deformity of the intervertebral disc.

April 19, 1937: Patient was visited in his own home. He is very cheerful and confident of his ultimate recovery. The spine is well reduced and soundly healed. He has no pain in the back. Sensation extends to both knees, where there is hyperæsthesia. Patient states that sometimes he has shooting pains which radiate towards the feet and toes. Motor power present in quadriceps, adductors, and hamstrings. He is able slightly to flex and extend the right foot, and less easily the left foot. Sphincters uncontrolled.

[This case was treated without skeletal traction, and developed a large sacral pressure sore in consequence. Massage and electrical treatment was started early, and is still being continued.]

Case 3.—F. B., coal miner, aged 25. Single. Admitted to Chesterfield Royal Hospital in the evening, following an accident two hours previously. Whilst working at a seven-foot coal face he had been hit by a fall of stone.

ON ADMISSION (September 30, 1936).—Gross kyphos present in the upper lumbar region. Paraplegia. Catheterized: urine clear. Shock was extreme, and it was doubtful whether he would survive the night.

X-RAY EXAMINATION.—Gross fracture-dislocation between the twelfth dorsal and first lumbar vertebræ. Only slight compression of first lumbar. Right lateral and forward displacement. Right superior articular process of first lumbar fractured; the left appears to be intact (*Figs.* 453, 454).

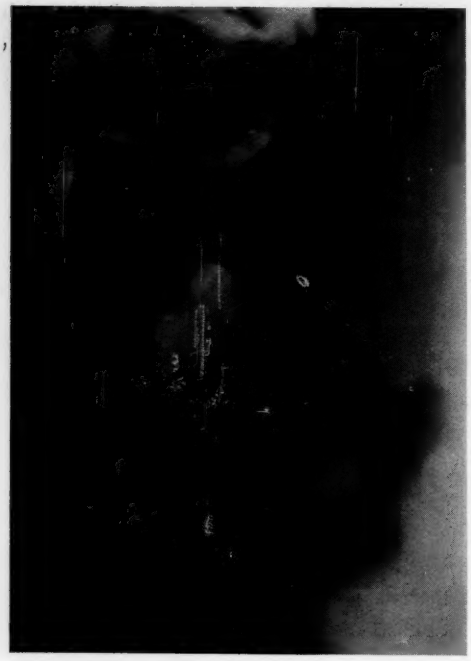

FIG. 453.—*Case* 3. Lateral radiograph. Gross fracture-dislocation of the twelfth thoracic and first lumbar vertebræ. An intact left superior articular process of the first lumbar can be well seen. Separation of anterior fragments of the first lumbar vertebral body, accompanied by slight anterior compression.

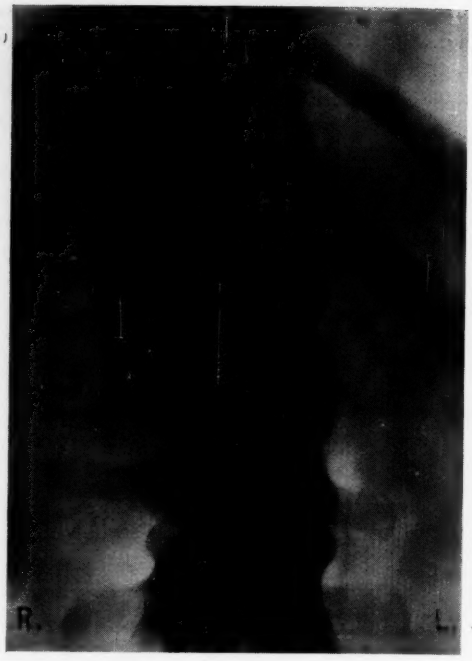

FIG. 454.—*Case* 3. Frontal radiograph. Right lateral displacement. Fracture of the right articular processes. Left side processes intact. Linear fractures of the first and second lumbar transverse processes on the right side.

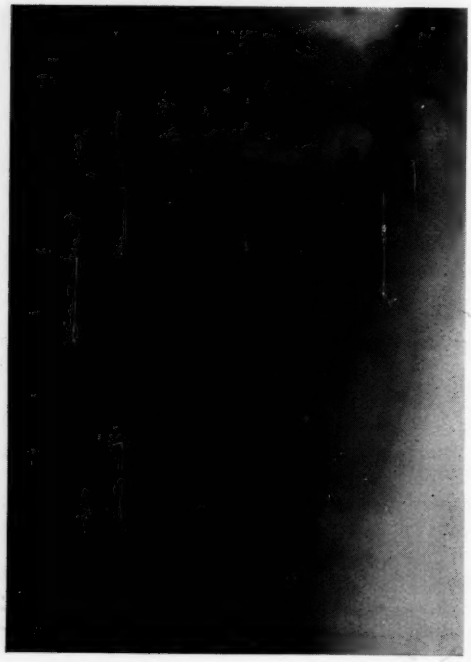

FIG. 455.—*Case* 3. Radiograph taken after operation. Accurate anatomical reduction has been obtained after the removal of a fragment of bone which had been lying between the two intact left articular processes. Owing to the poorness of the radiograph the salient features have been traced in.

TREATMENT.—

October 1, 1936: Patient very much improved. Hyperextension from the feet carried out with local anæsthesia. Radiograph not definite enough for printing, but it showed incomplete reduction, due to impaction of the left articular processes. Further interference was not considered owing to the gross nature of the injury and the condition of the patient. Recovery could only be regarded as an extremely remote possibility.

October 2, 1936: Anæsthesia had regressed to the upper thigh region, indicating that some of the lumbar nerves had escaped injury. Operation was therefore re-considered in the possible, if distant, hope that the cord also might have escaped complete section. This seemed just possible, in view of the lateral displacement. The patient's general condition had markedly improved.

Operation (A. H. G. M.).—Site of injury explored under local anæsthesia. No apparent leak of cerebrospinal fluid. Right articular processes fractured. Left processes intact and transposed. A piece of spongy bone, apparently separated from the surface of the lamina, lay between them. This was removed, after which accurate reduction followed, the processes slipping round each other (*Fig.* 455).

SUBSEQUENT PROGRESS.—A plaster bed was made, and the patient put up in it with skeletal traction, as already described. The patient appeared to do well for the first four or five days; enemata, however, failed to produce a satisfactory result. Finally, despite pituitrin, etc., a picture of paralytic ileus developed, and death occurred upon the thirteenth day.

AT AUTOPSY.—The wound appeared in fair condition, there being slight redness at the lower end. There were no pressure sores. The spine was exposed through the wound. All the lumbar nerves were apparently intact. The last inch of cord appeared to have been pulled out or attenuated beyond its full length. The outer layers were more or less intact, whereas the central portion was reduced to a pulp, showing that further recovery would have been most improbable.

CONCLUSIONS

Open operative reduction, carried out early, appears to be a rational method of treatment, and carries no risk of further trauma to the spinal contents. The criticism has been voiced that it has not yet 'cured' a case. True! It is our earnest hope, however, that before long we, or others, may encounter a case in which the damage to the spinal contents has not been so great as in the present series.

Whether there is always a certain amount of irrecoverable spinal injury in these cases we are not, at present, in a position to judge. In the present series alleviation can be claimed in two cases, and no change in one.

SUMMARY

1. Attention is called to a type of case in which fracture-dislocation of the spine with paraplegia is associated with transposition of the intact articular processes.

2. Manipulative reduction in these cases is not only contra-indicated, but, by hyperextension alone, is also impossible, owing to impaction of the processes.

3. The importance of recognizing the complication by radiography and the need for early operation is emphasized.

4. The treatment of an 'ideal' case is described.

5. Three recent cases are surveyed, with radiographs.

I should like to express my indebtedness to Mr. C. Gordon Irwin for his very generous help and encouragement in the preparation of this paper, and also to the Staffs of the Orthopædic Departments at the Royal Victoria Infirmary, Newcastle, and at Chesterfield Royal Hospital, for their willing help and co-operation.

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[1] BÖHLER, LORENZ, *The Treatment of Fractures*, 4th English ed., translated by E. W. HEY GROVES. Bristol: John Wright & Sons Ltd.

[2] BÖHLER, LORENZ, *Chirurg.*, 1935, vii, 654.

[3] BÖHLER, LORENZ, *Ibid.*, 720.

FRACTURED LUMBAR SPINE WITH UNILATERAL DISLOCATION

By A. WILFRID ADAMS, Bristol

This case is reported for two reasons: firstly, it is a rare form of spinal injury; secondly, open operation, when closed methods had failed, gave the clue to the exact nature of the damage and the means to mend it.

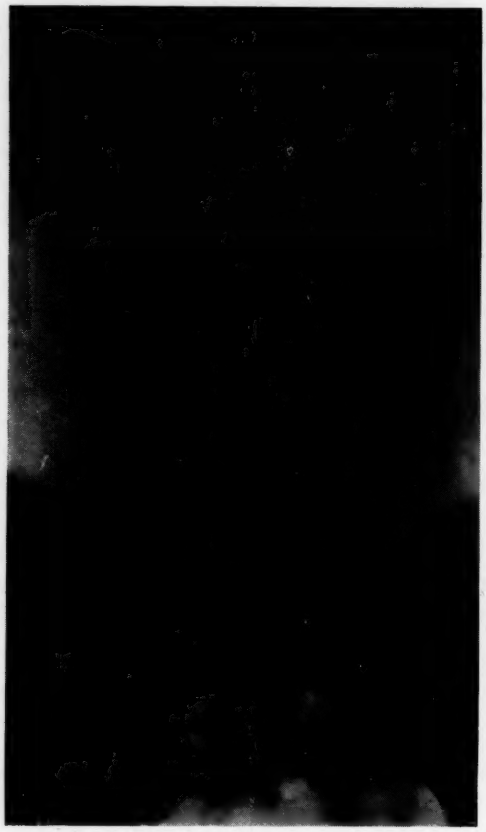


Fig. 456.—Antero-posterior radiograph of the lumbo-sacral spine, Dec. 16, 1935.

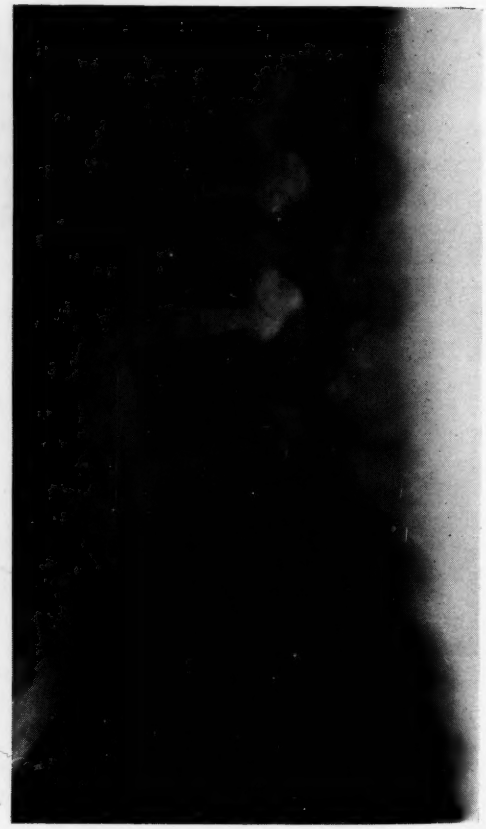


Fig. 457.—Lateral radiograph of the lumbo-sacral spine, Dec. 16, 1935.

On Dec. 16, 1935, the back wheel of his bicycle skidded, and J. W., aged 17, was thrown under a bus. The steering column crushed his back, and the front wheels of the bus had to be jacked up to liberate him. He could still move his legs, but could not walk, and complained of much pain while lying.

EXAMINATION.—His head and arms were marked with abrasions. The spinous process of the 5th lumbar vertebra made a painful projection on his back and all movements of the spine were resented. There was no evidence of deranged nerve-supply to legs or sphincters.

RADIOGRAPHY (*Figs.* 456, 457).—As the lateral view of the film was foggy at the level of the injury, the relationship of the bones was clarified by taking a tracing of their outline (*Fig.* 458).

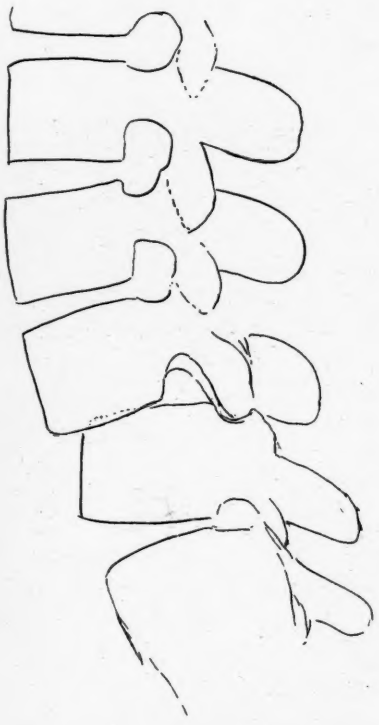


FIG. 458.—Tracing of the lateral view of the fracture-dislocation of the 4th lumbar vertebra. The inferior articular facet of the 4th vertebra has 'jumped' the 5th.

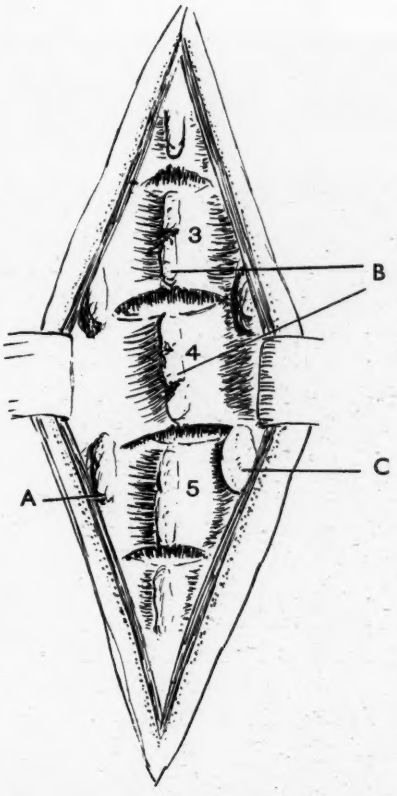


FIG. 459.—Sketch of condition found at operation. A Left joint between 4th and 5th lumbar vertebræ, intact; B, Fractured spines of 3rd and 4th lumbar vertebræ; C, Exposed right superior articular facet of 5th lumbar vertebra.

Obviously the spine had been displaced forward at the level of the 4th lumbar vertebra, and the body of that bone was seen impacted into that of the bone below. The nature of the damage to the articular facets and spinous processes of these vertebræ was difficult to define. In the antero-posterior view the right transverse processes of the first four lumbar vertebræ are seen torn from their roots and the spine is angulated (*Fig.* 456).

TREATMENT.—As the young man was faced with crippling arthritis and deformity, an attempt at correction was called for. Closed manipulation was used under spinal anæsthesia on the day of the accident. Various vigorous movements were tried while assistants exerted powerful traction on chest and legs. A plaster jacket

was applied to maintain hyperextension, and radiograms were repeated. These still showed the deformity, and led us to resort to open operation.

Operation (Dec. 20, 1935).—With the aid of spinal anæsthesia, the lower lumbar spine was exposed. I found the spinous processes of the 3rd and 4th vertebræ fractured. The superior articular facet of the 5th lumbar vertebra was bare on the right side, while the inferior articular process of the 4th had jumped over it and was deep to it. The lamina of this vertebra was lying obliquely astride

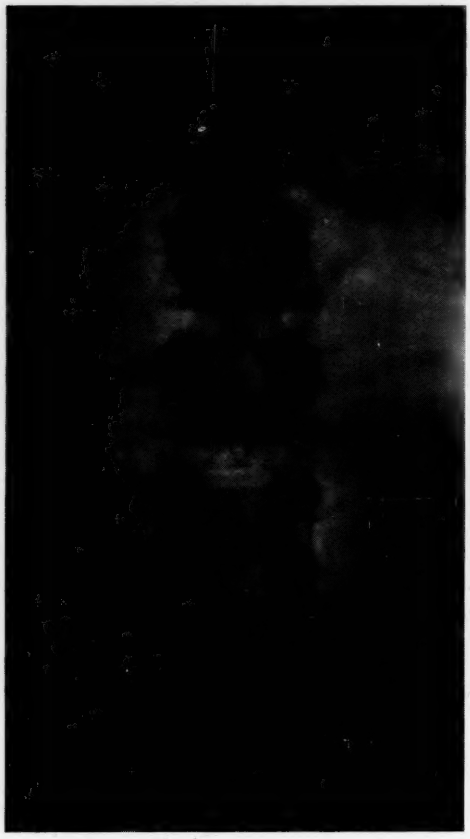


FIG. 460.—Antero-posterior radiograph of the lumbo-sacral spine, Dec. 21, 1935.

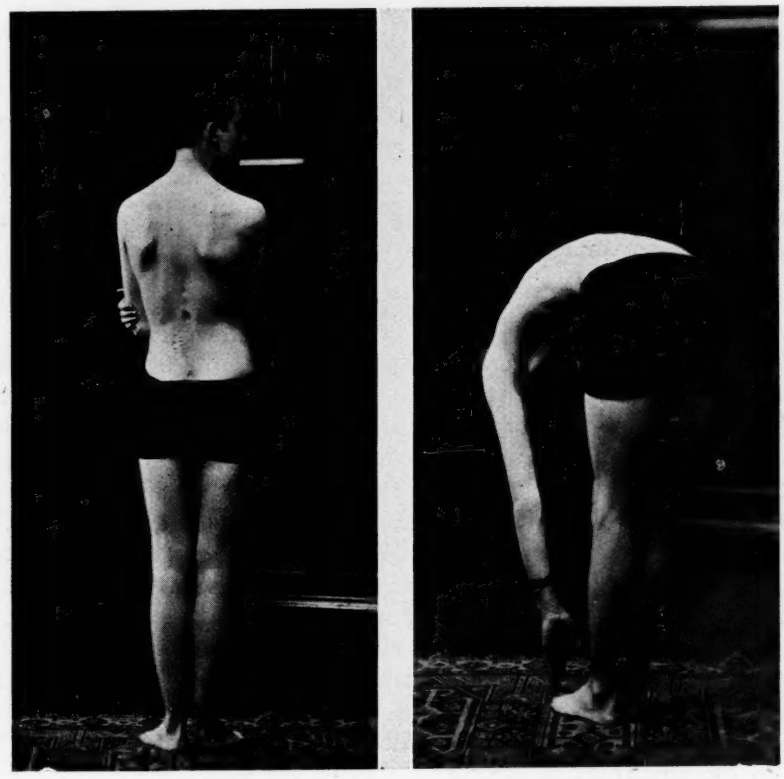
FIG. 461.—Lateral radiograph of the lumbo-sacral spine, Dec. 21, 1935.

the upper edge of the 5th. The articulation on the left was normal (*Fig.* 459). This explained the obscure relationship of the two vertebræ seen in the radiograms. The table was angulated to flex the spine sharply at the level of damage. Then, while chest and legs were vigorously pulled upon, a bone lever was used and eased the facet of the 4th upwards and backwards. This restored it to its proper seating on the 5th. It was found necessary to hyperextend the pelvis on the spine to retain the reduction. To this end it was necessary to apply another plaster-of-Paris.

SEQUEL.—Subsequent radiograms (*Figs.* 460, 461) showed the joint to be satisfactory, and the patient resumed active work six months later. Photographs

taken on April 12, 1937 (*Figs.* 462, 463), speak for themselves, and the patient is hoping to get into the Life Guards shortly.

Summary.—This was a case of fracture combined with partial dislocation of the spine. It is a half-way house between crush fracture and the typical and



FIGS. 462, 463.—Photographs of patient taken 16 months after operation.

hopeless fracture-dislocation. Careful scrutiny of radiograms enables the observer to make the correct diagnosis of a condition which otherwise, owing to absence of paraplegic symptoms, might be labelled as a crush fracture. Once diagnosed, it defies reduction by the closed method of Watson Jones, and affords one of the rare indications for early open operation for fractured spine.

FRACTURE OF THE OS CALCIS

By W. J. EASTWOOD, Liverpool

During the past thirty years there have been many publications dealing with the treatment and results of fracture of the os calcis. The one outstanding feature has been the surprisingly unanimous verdict given in regard to the prevalence of unsatisfactory end-results. Thus Golebiervski (1897), Cotton (1908), Magnuson (1923), and Satta (1923) all report a high percentage of their patients as suffering from some permanent disability.

CAUSES OF UNSATISFACTORY END-RESULTS

In view of these unsatisfactory results it is not surprising that numerous suggestions have been advanced in an effort to explain the divergent results in apparently similar fractures. For years the general consensus of opinion has been that involvement of the subastragaloid joint constitutes the commonest single cause of failure, and for the purpose of prognosis two main types of fractures have been described: (1) Fractures not involving the subastragaloid joint; and (2) Fractures in which there is damage to this joint. More recently a careful study of radiographs and early operative interference has brought to light the fact that in fracture of the body of the os calcis involvement of the subastragaloid joint to some extent is almost inevitable.

In addition to arthritis of the subastragaloid joint, failure has also been ascribed to the following causes:—

1. Loss of the normal arch, a condition which is frequently followed by bony pressure on the structures of the soft tissues of the sole.
2. Spur formation.
3. Outward deviation of the heel, with static flat-foot.
4. Simple flat-foot, from weakness of ligaments.
5. Pain due to pressure from the presence of excess of bone below the external malleolus.
6. Fibrosis of tendons and joints of the foot.
7. So-called osteitis or alteration in the structure of the affected bone.

Many of these suggested causes are highly problematical; rarely does a spur, even when of considerable size, cause symptoms, and when present and troublesome, relief will follow its removal (*Figs.* 464, 465). Mobile flat-foot, whatever the cause, can be relieved by treatment in which the weight-bearing line of the foot is altered. Although a mass of bone was frequently seen under the external malleolus in the early X-ray photographs, a later photograph almost invariably showed that this abnormal growth had been absorbed completely or partially, and in patients who complained of discomfort in the foot, inversion was more painful than eversion. The foot which is rigid from adhesions or so-called fibrosis of joints and tendons can usually be relieved by manipulation, massage, and use. The so-called osteitis or alteration in the affected bone which causes pain on weight-bearing should also

cause discomfort on lateral compression of the bone without joint movements, and in none of the patients reviewed for this paper was this sign elicited. In

FIG. 464.—Radiograph of right foot. Male, aged 30 years. Bricklayer. Accident, April 20, 1935. Fracture of os calcis on both sides. Back at work in fifteen months, with no complaints and no tenderness over the site of spur formation.

FIG. 465.—Radiograph of same case, July 13, 1935, showing gradual absorption of spur on under surface of right os calcis.

seeking a cause, therefore, for the disability which may follow this accident, it would appear that arthritis of the subastragaloid joint must be the most common cause.

METHODS OF TREATMENT

Broadly speaking, there are four recognized methods of treatment: (1) Restoration of anatomical alignment; (2) Application of plaster with the foot in a neutral position and the arches moulded, no attempt being made to correct the deformity; (3) Early arthrodesis of the damaged joints; (4) Late arthrodesis of the damaged joints.

1. Restoration of Anatomical Alignment.—The ideal of restoration of the normal anatomical alignment is stressed by Böhler, who states that, with care and attention to a somewhat complicated technique, anatomical reposition of the fragments is possible even in the worst type of fracture, and that when this correction has been accomplished a perfect result must of necessity occur. In accepting this statement one cannot help recalling many instances of fractures into other joints in patients over forty years of age where, in spite of the X-ray appearance of apparently perfect anatomical alignment, an arthritis has subsequently developed; and it is doubtful if anything like 100 per cent full recoveries will follow the adoption of such a method as this, in which there are possibilities of failure or even disaster in inexperienced hands.

2. Plaster Fixation in a Neutral Position.—The second method, that of treating the foot in plaster in a neutral position with the arches of the foot moulded into approximately their normal alignment, has been constantly attacked for the last twenty-five years, but is still used by many surgeons; and in spite of its obvious limitations, it undoubtedly gives results which compare very favourably with any other method of treatment, although it cannot be described as consistently successful.

3. Early Arthrodesis.—Because of these failures Wilson and many other writers recommended a third line of treatment—namely, early arthrodesis of the subastragaloid joint. In my limited experience of this operative procedure the results have been unsatisfactory. At the operation the affected joint was so much more disorganized than the X-ray appearances suggested that any planned operative procedure was difficult, and in fact appeared to be unnecessary. The end-results also were most disappointing, and did not encourage me in any further practice of the method. Conn has gone a step further, stating that, as the midtarsal joint works in close association with the subastragaloid, a satisfactory result cannot be obtained unless this joint also is fused. This method of Conn, even when successful, must lead to the development of a very rigid foot, which would be a sufficient excuse for many workmen to claim compensation on a large scale; and for this reason alone, in my opinion, the method should only be used when gross destruction or long-standing dislocation of the midtarsal joint demands the most radical procedure.

The arguments used against early arthrodesis of these joints can be used equally well against routine destruction of the subastragaloid joint alone. Frequently fracture of the os calcis results in a painless foot with a slight degree of movement in the subastragaloid joint. Even this small range of movement is of the greatest functional advantage, and is preferable to a condition in which all movements are lost, even assuming that the ankylosis is sound and painless.

4. Late Arthrodesis.—Finally we are left with the fourth method, which consists of the arthrodesis of those joints which after some method of conservative

treatment are the site of painful movements. This method, if successful in producing a sound painless ankylosis, may produce some improvement in the absence of tenderness, but with the great disadvantage that it has increased the patient's period of disability by at least six months. If, however, we could, either by X-ray or clinical examination, separate the probable successes from the possible failures of conservative treatment, then an early arthrodesis of the affected joints in the latter group might improve the results and hasten the patient's return to work.

REVIEW OF 47 CASES

For the purpose of this paper I reviewed 47 cases of fracture of the os calcis in which there had been some displacement of the fragments and distortion of the normal outline of the bone. The number is not very large, but they have provided many interesting facts, one of the most striking being the period of time between the date the man was discharged as fit for work and the date at which he actually returned to work. In this series this intervening period varied from one day to nearly a year. In striking contrast is the period which elapsed between settlement of the compensation claim and the date of the man's return to work or to the labour market in search of work.

Briefly to summarize these cases, in 1 case a subastragaloid and midtarsal arthrodesis was performed, whilst another, a badly comminuted fracture, performed its own triple arthrodesis without operative interference. In 2 instances a late subastragaloid arthrodesis was considered necessary, whilst 2 were treated by skeletal traction as recommended by Böhler. The remaining 41 either had no treatment for the fracture itself or simply a plaster fixation of the foot in a neutral position with the arches moulded.

The one patient, a woman, on whom a triple arthrodesis was performed, has undoubtedly been improved, but still complains of pain after walking half a mile or on walking for a short distance on rough ground. She is quite unable to do any heavy housework, such as washing, spring-cleaning, etc. The other triple arthrodesis, the result of severe comminution, returned to light work after fifteen months, but states, and I think with reason, that he is unable to return to his previous work as a collier owing to his inability to adapt the foot to the rough road of the mine and coal face.

Of the two patients who were treated by late subastragaloid arthrodesis, in one case the foot is rigid in all directions, he complains of pain below the malleoli, walks with a stick, and is still on compensation five years after the accident and three and a half years since the date of operation. Actually, this result was the worst of the series, but the patient is definitely not co-operative. The other patient returned to full work one year after the operation, which he says improved him considerably, but he still complains of pain in the heel in damp weather and on twisting the foot.

One of the two patients treated by skeletal traction returned to work in one year with no movements of the subastragaloid joint, but only a little pain in wet weather. Her radiograph (*Fig.* 466) might be that of a patient treated less laboriously by plaster, except for the hole in the os calcis still present three and a half years after the insertion of the wire. The other, a clerk, returned to work in five months, but did not get complete relief for over two years. He can now

dance, play football, and has no complaints except some loss of movement. His radiograph is rather remarkable (*Fig.* 467). A solid bony ankylosis has occurred, although the only form of treatment attempted was skeletal traction.

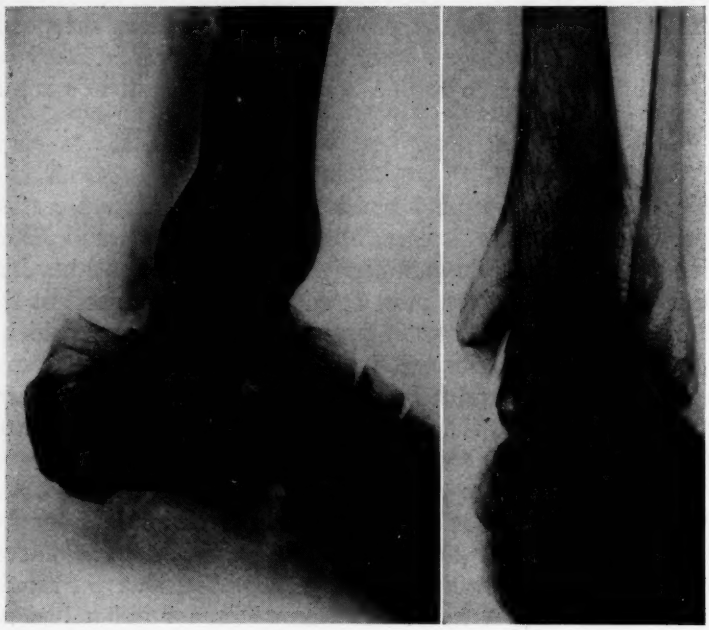


FIG. 466.—Radiograph taken Sept. 13, 1935. Female, aged 55 years. Sewing machinist. Accident, Feb. 8, 1932. Off work for twelve months. Returned to full work. Compensation, £250.

Of the other 41 patients (who had either no treatment or a plaster applied to keep the foot in a neutral position and protect it from weight-bearing), 1 did light

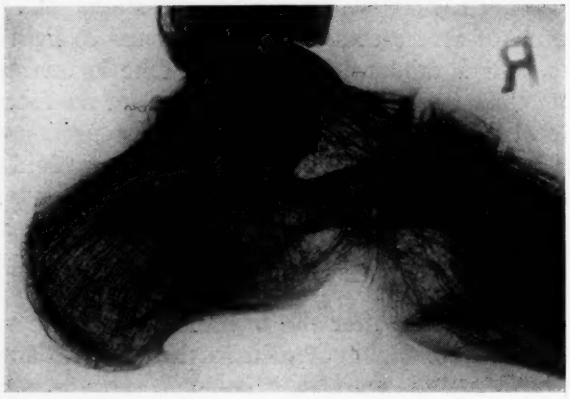


FIG. 467.—Radiograph taken Oct. 19, 1935. Male, aged 21 years. Clerk. Accident, January, 1931. Skeletal traction. Off work for five months. No compensation. Note ankylosis of subastragaloid joint which occurred without operative interference.

work until his case was settled, but following dismissal has not worked since because of aching in the foot and inability to compete with normal men on the dockyard labour stands. Although unemployed and living in Liverpool he refuses to return

for examination. His radiograph at the time of the accident is one in which a good prognosis would be expected.

There are 7 on lighter work. One, a steeple-jack, is now a club steward with a foot completely free from pain; his explanation for his change of occupation was that a fall of forty feet had cured him of any desire to climb heights. Another is unable to manage the two miles over the rough road from the mine shaft to the coal face, but works as a labourer when he can get such employment. He complains that sudden wrenching of the foot causes pain. The third, a warehouse porter, became a builder's labourer and then a caretaker in a block of flats; he complains also of pain on sudden twisting of the foot, and as a cotton-porter or a builder's labourer this gave him a feeling of insecurity. The fourth, also a builder's labourer, now runs a kiosk and walks five or six miles daily delivering newspapers. His complaints are similar to those of the previous man. The fifth is an engineer in a factory, and as he cannot climb ladders with comfort he has been given work which confines him to one floor. The other two are colliery carpenters, and are now employed in work on the ground. Both suffered from bilateral fractured os calcis and both patients cannot climb ladders with safety.

The other 33 patients are back at full work or have carried out their previous occupation and have been stopped owing to trade depression. Most of them complain of some mild disability, mainly that the foot is not as strong or painless as the other foot, but the disability is not enough to prevent them working or to cause them to seek further treatment. With three exceptions all these patients are manual labourers of some description. By this is meant they are walking or standing all day—window-cleaners, builders' labourers, steeple-jacks, colliers, dockers, tramdrivers, stewards, etc. The three exceptions are a machinist, who uses the affected foot to work her treadle, a bus-driver, who works his clutch with the injured foot, and a booking clerk, respectively.

DISCUSSION

The problem therefore appears to be not how to get the patient back to work, but how to reduce the period of disability, which, in this series, varies from one week to two and a half years, a difference for which no clinical or radiological reason can be given. The speed with which all patients returned to work after their claim had been settled strongly suggests the influence of the workman's solicitor, and this, I am sure, is the biggest problem in this, as in most fractures sustained at work or in the street. Most surgeons can remember patients who have been seen for some other condition, examination revealing an old fracture of the os calcis which was treated as a sprained foot. These patients have invariably done well and their period of disability was negligible. The case of a ship's officer is an example (*Fig.* 468).

When one compares the radiograph in *Fig.* 469 of a collier on light work complaining of pain sufficient to prevent him returning to full work with the radiograph in *Fig.* 470, also of a collier on full work, complaining of some discomfort but not enough to prevent him from working, and when a similar comparison is made between the radiographs in *Fig.* 471 and *Fig.* 472, one finds it difficult to assign a reason for the divergence of results. Finally, on comparing them with *Figs.* 473 and 474, radiographs of patients on full work who suffer no disability, the problem becomes even more difficult.

FIG. 468.—Radiograph taken May 1, 1935. Male, aged 35 years. First mate. Accident, 1917. Off work for two months. Returned to full work. No compensation.

FIG. 469.—Radiograph taken Sept. 29, 1935. Male, aged 44 years. Collier. Accident, Feb. 20, 1932. Off work for nine months. Works as a labourer. No compensation.

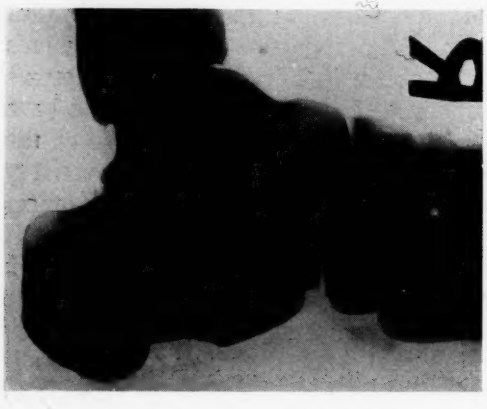


FIG. 470.—Radiograph taken Oct. 16, 1935. Male, aged 34 years. Colliery fitter. Accident, July 31, 1933. Off work for seven months. Returned to full work. No lump sum.

FIG. 471.—Radiograph taken Sept. 17 1935. Male, aged 39 years. Labourer. Accident, Jan. 29, 1931. Off work for two years. Runs a kiosk. Compensation, £500.

A careful study of all the radiographs and the patients in this series suggests that the best results are obtained in the comminuted fractures provided there is no displacement of the midtarsal joint, and the most difficult to get entirely free from pain is the fracture of the neck of the os calcis with slight displacement upwards of the anterior fragment. In those patients who were treated conservatively and had not returned to full work, the usual complaint was of a severe pain on sudden inversion, eased immediately by shaking the foot, and pain accompanied usually by a complaint of stiffness eased by use. These disabilities suggest the cause as being adhesions rather than active arthritis, a condition which might easily

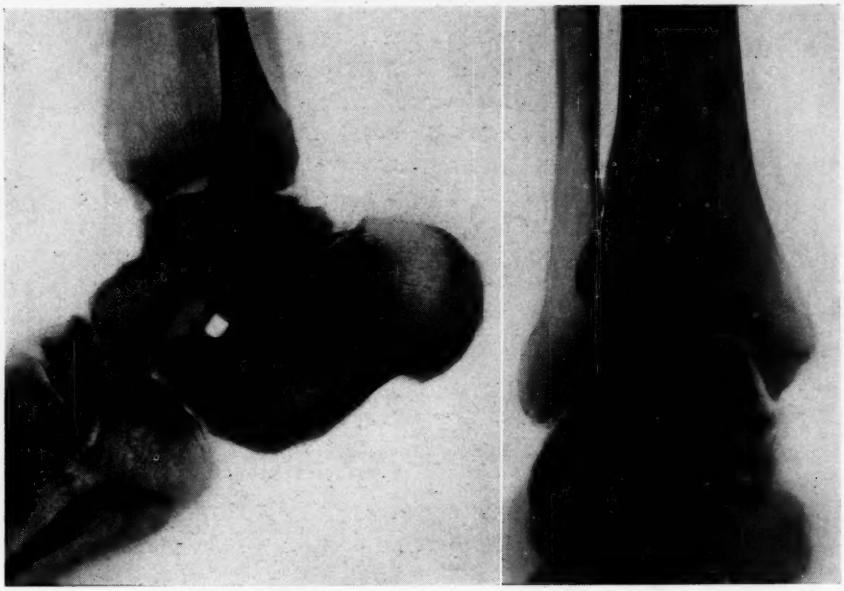
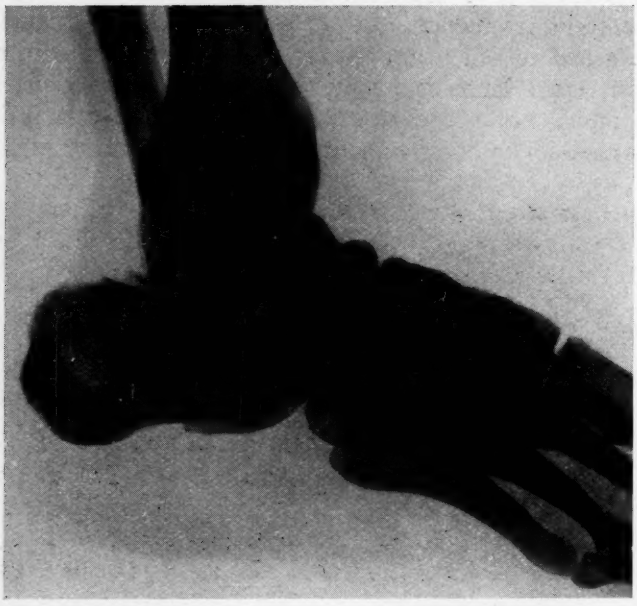


FIG. 472.—Radiograph taken Sept. 13, 1935. Male, aged 46 years. Miller. Accident in 1925. Off work for six months. Returned to full work the day after manipulation. No lump sum.

improve with manipulation. None of the patients who are on light work would permit this to be done; all were content that, even so long after the accident, the foot was still improving.

Another interesting discovery in this investigation was the absence of importance of the 'salient angle', the preservation of which forms so important a part of the modern method of treating this fracture. In every one of the cases in this series the angle was diminished, and in many of the fractures it had disappeared. One more popular belief which was also proved to be incorrect was the statement that elevation of the body of the os calcis which follows this fracture results in a relative lengthening of the calf muscles and a consequent inability of the patient to walk on the toes. Several of the patients in this series could only carry out this exercise for a very short distance; but this inability is not due to the calf muscles acting at a disadvantage—it is caused by the slight inversion of the os calcis at the subastragaloid joint, which occurs when a patient rises on to the toes. The inability to perform this exercise occurred only in those patients who had discomfort on sudden inversion of the foot, and in my opinion was the result of pain, and not of

weakness of the calf muscles. The improvement in the performance of this exercise was very noticeable following a manipulation of the foot, an operation which was performed on 29 of the patients in this series of cases.



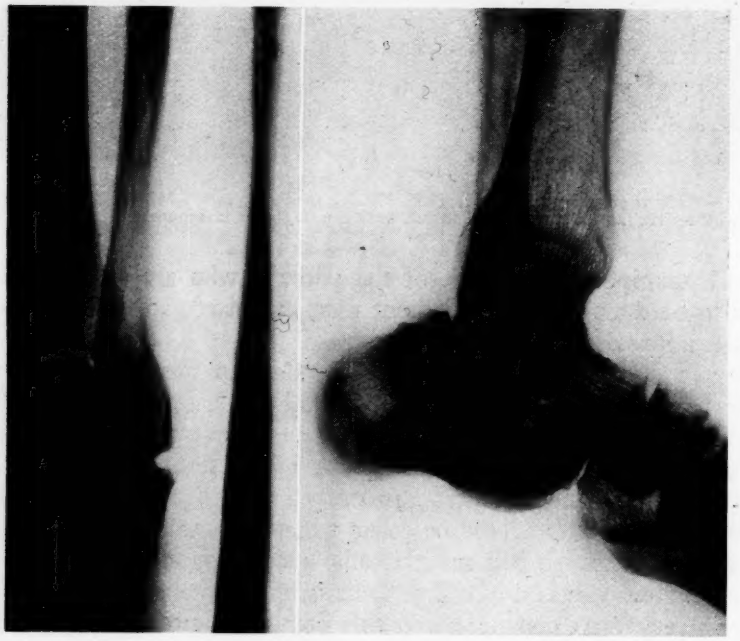
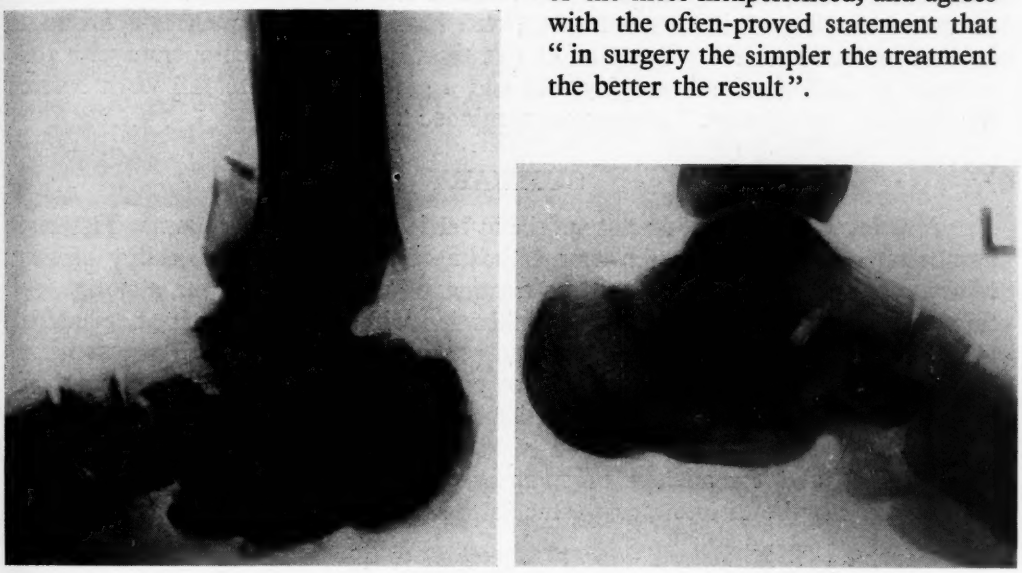


FIG. 473.—Radiograph taken Sept. 13, 1935. Male, aged 35 years. Brickwork pointer. Accident, July, 1927. Off work for fifteen months. Returned to full work. Compensation, £100.

I started this follow-up with a comparatively open mind, influenced a little by the literature on the subject, and quite prepared to expect poor results. My

opinion now is that the ideal treatment is non-interference and freedom from weight-bearing preferably for three months with the foot in plaster, followed by active use with gradually increasing massage and assisted movements. At the end of a further eight to twelve weeks a manipulation under general anæsthesia will materially hasten a return to work in those cases in which progress is slow. Although this method has been satisfactory in a small series of cases reviewed for this paper, there will always be a small percentage of unsatisfactory results, but it is doubtful if any form of treatment will produce 100 per cent successes, and the routine suggestion has the merit that it is simple and safe even in the hands of the most inexperienced, and agrees with the often-proved statement that " in surgery the simpler the treatment the better the result ".



A B

FIG. 474.—Radiographs taken Sept. 24, 1935. Male, aged 50 years. Window cleaner. Accident, October, 1926. Bilateral. Off work for six months. Returned to full work. No lump sum. Re-admitted, Sept. 24, 1935, suffering from compound fracture of right tibia and fibula. A, Right foot; B, Left.

It may be of interest at this stage to mention a statement made by an insurance manager when speaking to me of this type of fracture. He said that he regretted when anyone claiming on his company was treated by an orthopædic surgeon for this condition, and he was delighted to hear that the man was attending his own doctor for " a bottle of embrocation and encouragement ". He went further, and said that an arthrodesis or surgical interference usually cost his company at least another hundred pounds, apart from the extra weekly compensation due to delay in settling the case.

Statistics can be made to prove anything, even the truth at times, and bald average figures from a number of patients without any mention of occupation and special circumstances are of little value. Thus the average period of disability in these patients who returned to full work was 9·17 months, but this series includes 1 case, a hairdresser, who returned to work in a week wearing a walking caliper, 4 bilateral cases, 1 case, a window-cleaner, who was incapacitated for two and a half years, and 13 others who were off for over ten months. In contrast to these figures the average disability of the 8 patients who returned to light work was

19·8 months. Of these, one, a steeple-jack, found more congenial work as a club-steward three and a half months after the accident, and another was a patient on whom a triple arthrodesis was performed four years after her injury.

Regarding the cost to the insurance companies of this fracture, only 31 out of the 47 patients were insured. Apart from the weekly compensation paid to these patients, the average amount paid out in lump sums when the case was settled was £56 18s. Compare this figure with that supplied me by an insurance company. In a short series of 12 patients the average sum paid out when the case was settled was £159 4s. The reason for the disparity between these two sets of figures is not hard to find; in my series a considerable number were employed by large combines carrying their own insurance, and having, in consequence, a financial interest in each accident. Every effort was therefore made to co-operate with the surgeon in finding suitable employment and a gradual return to full work before the patients had become 'compensation-minded'.

SUMMARY

A review of 47 cases of fracture of the os calcis, comprising 53 separate fractures, has been undertaken to obtain some estimate of the permanent disability of this injury. Although several methods of treatment were employed, the majority (47 fractures) were treated by simple immobilization without any attempt at reduction of the deformity. In this small series 80 per cent returned to their pre-accident work, and although the majority did not complain of any discomfort, several of these patients admitted that the injured foot was painful after a hard day's work or in wet weather. An examination of the period of time these patients were incapacitated, and the amount of compensation paid to them, brings out some facts which may be of interest or value in the treatment of this fracture.

CRITICAL REVIEW

MALIGNANT DISEASE OF THE LARGE INTESTINE

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Although this review is concerned essentially with the surgical considerations arising in relation to malignant disease of the large intestine, there are certain anatomical and physiological features of the area which are worthy of comment. A disturbed physiology may afford the clues which lead to an accurate interpretation of disease; physiological considerations may play their part in creating and formulating variations in morbidity, while they must of necessity influence one's decision in the technique of operation and in the details of post-operative care. The importance of anatomy is equally clear, for an accurate appreciation of the lymphatic and vascular systems is the basis upon which the success of surgical procedure so largely depends.

THE PROXIMAL AND DISTAL COLONS

A subdivision of the large intestine into right and left halves is based upon the facts of development. That portion which we speak of as the right colon, and more accurately as the proximal colon, extending as far as the left half of the transverse colon and originating from the mid-gut, is isogenetic and in some respects isomorphic with the small intestine, while the left half or distal colon, arising from the hind gut, has features which throughout post-natal existence indicate its distinctive inception. It might be anticipated that the developmental variations would be evidenced by persistent structural peculiarities, but such are not apparent to any marked degree. It is true that certain distinctive features have been described; according to Gleize-Rambal[1] the descending colon differs from the ascending and transverse colons in several structural respects. He draws attention to the distribution of the tæniæ, to the thickness and arrangement of the muscular coats, and particularly to the fact that the mucosa of the descending colon is more closely attached to the muscular coat than is the case in the proximal colon. It is doubtful whether these variations have any intimate association with surgical conditions, unless it be that the last mentioned has some influence on the manner in which tumours grow and extend. There can be no dispute that the distinction between the proximal and distal colons is manifest in the blood-supply of the two parts; much attention has been paid to this matter, and surgery has taken cognizance of the distinction by adapting its procedures in terms of the vascularity of the part affected. I need not elaborate the point at this stage, because it is alluded to in detail later.

The researches of many physiologists, and particularly those of Bayliss and Starling, have taught us that there are interesting distinctions of nerve-supply

and distribution. More recently the work of C. J. Hill, McCrea, and M'Swiney has explained much that was obscure in the functional activities of the parts. In so far as the surgical considerations are concerned, the facts of practical significance may be summarized as follows: While the sympathetic innervation of the large intestine is relayed on a more or less uniform basis through the cœliac, the aortic, and inferior mesenteric plexuses, the parasympathetic supply is derived from twin yet distinctive sources, for the vagus is the parasympathetic medium of the proximal colon, while the long pelvic nerve (pelvic splanchic nerves) distributes a corresponding stimulus to the distal colon. It may be, however, that the distinctions of the parasympathetic innervation have further points of practical significance. There is some evidence that the parasympathetic innervation of the distal colon results in more efficient functional effects than that manifested by the vagus innervation of the proximal colon, and, if we accept the teaching that the function of the parasympathetic is augmentory, it seems logical to conclude that the peristaltic action of the distal colon is a more intense and effective process than that evidenced in the proximal segment. It may be that these considerations have important bearings upon such procedures as colonic anastomosis.

The lymphatics of the colon were investigated by Jamieson and Dobson[2] in 1909. So efficient was the study that no additional knowledge of any significance has been acquired since the results of their work was published, and to-day it forms the basis of the scheme upon which large intestine resections are planned. The lymph-stream of the transverse colon has been studied by Richard.[3] He points out that the lymphatic arrangements of this region are more intricate than those of the ascending and descending colons; that, when the intermediate lymph nodes and vessels lying in relation to the middle colic artery are blocked, secondary streams are established which communicate with the great omentum, the hilar glands of the spleen, the lymph-vessels at the greater curvature of the stomach, the retro-pyloric glands, and even with the lymphatic distribution in the capsule of the liver. These are ominous possibilities, and it is apparent that they must reflect adversely upon the prognosis and upon the success of resection procedures.

Consideration of the distinctions in general physiology need not concern us beyond the general statement that the proximal colon is concerned with absorption, while the main function of the distal segment is one of storage. An obvious association of the distinction is a variation in the state and consistence of the bowel content; matter in the cæcum is of a semi-fluid character, the degree of consistency is increased in the transverse colon, and in the distal colon the contents show a varying degree of inspissation relative to such factors as the time period over which the fæces have been retained. These are simple and obvious facts, but their application in terms of surgical procedure is apparent.

The character of the colon content is in some measure related to the output of mucus by the colon wall. The physiology of the process has been studied by H. Florey,[4] and the disposition of the goblet cells in the wall of the large intestine has been investigated by R. W. Harvey.[5] There is evidence that the concentration of the mucin-producing cells is greatest in the distal colon, and particularly in the segment between the lower end of the descending colon and the rectum. No doubt the disposition is designed to meet a physiological demand, but it provides yet another distinction between proximal and distal colons, and it may be that it has a bearing upon the histopathology in the respective portions of the large bowel.

Such is a summary of some of the distinctions between proximal and distal colons. Criticism may arise because questions of development and morphology, of anatomy and physiology, have been included in a review which is primarily concerned with malignant lesions, but many of the questions which have been under discussion have significance when surgical problems are under consideration, and as a general principle it is important to recognize the distinctions which exist between proximal and distal colons.

W. J. Mayo, Arthur Keith, and others have brought out the fact that the large intestine really begins near the splenic flexure, while the proximal colon, and particularly the cæcum, is more nearly akin to a second stomach; and when we apply this conception in terms of the conditions with which this review is concerned, we appreciate the significance of a statement by Larson and Bargen[6] in their article on the physiology of the colon to the effect that "a malignant lesion of the right side of the colon clinically called attention to itself by disturbances of the physiologic equilibrium, in sharp contradistinction to the obstructive phenomena characteristic of the distal part of the colon".

THE BLOOD-SUPPLY

The disposition of the blood-supply to the large intestine is a matter of great significance. It demands consideration because it is one of the factors that spell success or failure in our procedures, and it perhaps more than any other feature has influenced and oriented the design and character of large-intestine operations.

Various investigators have studied the blood-supply of local areas of the large bowel, particularly Pope and Judd[7] and Hamilton Drummond,[8] but the most complete description of the colon circulation is that afforded by Stewart and Rankin.[9] It is unnecessary to elaborate the anatomical details, but certain individual features call for comment. There is the possibility of variation in the source and distribution of the main vessels. The ileocolic artery is a constant structure, though there may be variations in the manner of its distribution to the cæcum. The right colic is a relatively inconstant vessel; Stewart and Rankin found it to be absent in 18 per cent of cases, while it was only in 40 per cent of instances that its source and distribution followed what is regarded as normal anatomical relations. The mid-colic artery, on the other hand, is less liable to variations, though its absence was noted by the same observers in 5 per cent of cases. An interesting feature of the vessel is the frequency with which it supplies a branch which passes to the splenic flexure (the accessory middle colic artery of Waldeyer). (*Fig.* 475.)

The blood-supply of the distal colon, arising from the inferior mesenteric artery, presents a more uniform scheme than that of the proximal segment, and variations in its distribution are extremely rare. The marginal artery is an interesting feature. The name was applied by Hamilton Drummond in 1913 to the more or less continuous vessel which runs at a variable distance from the inner perimeter of the bowel from the ileocæcal valve to the lower part of the sigmoid colon. It obtains its supply from each of the primary vessels, and it ensures a uniformity of distribution to the entire area of the large intestine. But its outstanding feature from a practical standpoint is its value in providing a channel of anastomosis. It has been described as the only connection between the superior and inferior mesenteric arteries, and its efficiency in this respect was shown by Drummond,

when, having tied all the main arteries of the colon near their origin, he succeeded in filling the sigmoid vessels with material injected into the ileocolic artery. The

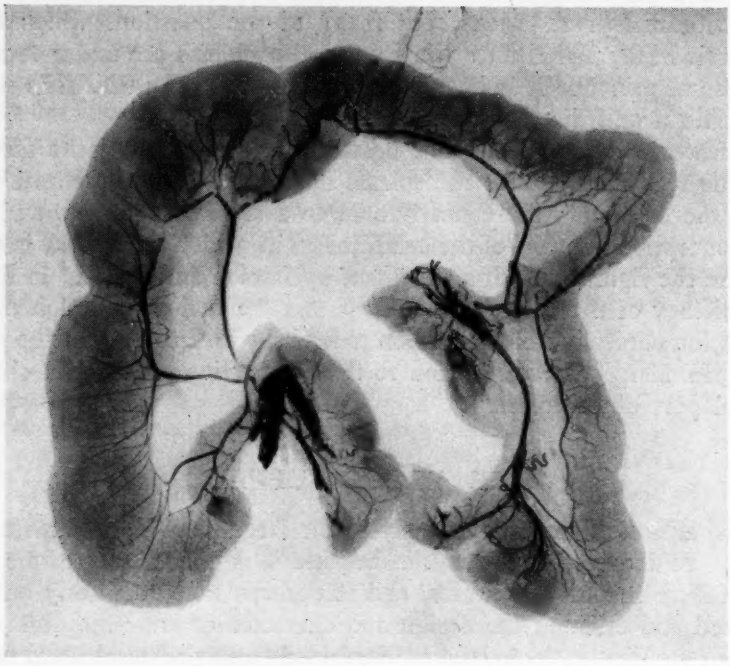


FIG. 475.—The blood-supply of the large intestine. The superior and inferior vessels were injected with barium celloidin (alloidin) mixture and the soft tissues cleared with benzole. The illustration is a radiograph of the injected specimen.

marginal artery provides the distribution to the bowel wall, and the manner of its arrangement has been described by Jean Meillere.[10] From the main or marginal vessel two long branches arise, one distributed anteriorly, the other posteriorly. They lie superficial to the median tænia, and they encircle the bowel in the subserous layer. Short branches arise from them to penetrate the muscular coat and supply the mucous membrane. The course of the long branches brings them into relationship with the bases of the appendices epiploicæ, and they are frequently looped at this point, where small accessory vessels are given off to supply the appendices. Thereafter they pass beneath the anterior and posterior tæniæ respectively, to break up into an anastomosis on the anti-mesocolic surface of the bowel. (*Fig.* 476.)

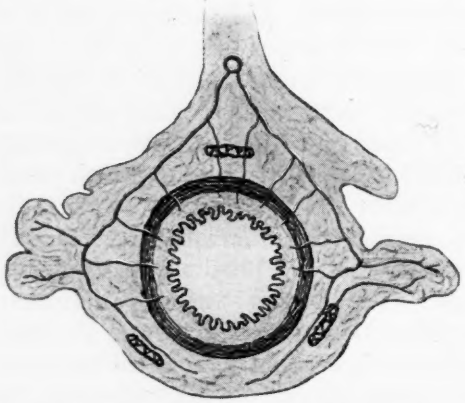


FIG. 476.—The circulation from the marginal artery to the colon wall, illustrating the distribution to the appendices epiploicæ. (*After Jean Meillere.*)

Meillere draws attention to an important fact relating to these arteries. In the course of a colic resection adjacent appendices epiploicæ are excised; it may

be a wise precaution, but if the excision is unduly radical, and particularly if the appendix is pulled away from the bowel wall before the severance is made, the related artery is apt to be damaged. The result is an ischæmia of the antimesocolic area, and a situation which may imperil the security of the subsequent anastomosis. The possibilities are well shown in a series of infected specimens illustrated in Meillere's article.

Among the various considerations which have been alluded to there is one point of real practical significance—it is the variability which may exist in the distribution of the primary vessels, particularly in relation to the proximal colon. Statistics suggest that what the anatomist would describe as an abnormality is almost as frequent as the disposition which anatomy claims to be normal. The marginal artery may be a remarkable anastomotic channel, but if an unduly drastic ligature of the primary supply is carried out the marginal vessel will prove insufficient. Each case must be determined in terms of the local conditions, and the rule which Stewart and Rankin suggest is a wise one—" The two adjacent vessels should be investigated before one artery is occluded ".

THE PLACE-INCIDENCE OF THE TUMOUR

For the purpose of this review an analysis has been made of 900 cases of carcinoma of the colon treated in the Edinburgh Royal Infirmary over a period of fifteen years (1921–36). Considered on the basis of the site of occurrence, the following are the figures :—

Tumour Site	*Percentage Occurrence*
Cæcum	19
Ascending colon	7
Hepatic flexure	6
Transverse colon	14
Splenic flexure	10
Descending colon	3
Sigmoid colon	41

The record is similar to that presented on many previous occasions (Judd,[11] Körte,[12] Peterman[13]), and it may be said that all statistics agree that the highest percentage of malignant tumour occurrence is encountered in the sigmoid colon, while the next most frequent site is in the cæcum. It is a curious fact that the commencement and the termination of the colon should be the areas most frequently affected, and there must be an explanation, particularly for the overwhelming proportion encountered in the sigmoid. Many hypotheses have been advanced, but as yet no confirmatory information is available. It has been suggested that delay in the passage of contents at these points, and particularly at the sigmoid, is the explanation, and it has been assumed that delay means increased irritation. But in this event constipation should be a factor predisposing to carcinoma of the large bowel, and it will be agreed that no direct association between the two conditions has been established.

The relation between polypi and malignant disease will be commented on later, but at this point it may be said that the view has been advanced that the high percentage of sigmoid carcinoma is attributable to the fact that this is the area in which polyps are relatively common, and what is regarded as a primary carcinoma of the colon is actually a malignant change in a preceding polyp. There is no doubt

that the incidence of polyps is greatest in the terminal portion of the distal colon (Erdmann and Morris[14]), but if this were the association which explained the high incidence of sigmoid cancer, the collateral development of simple and malignant tumours would have been a constant finding, while it will be agreed that the association is exceptional.

Reference has been made to Harvey's work on the disposition of goblet cells in the wall of the large bowel. The largest concentration of this tissue is encountered in the sigmoid colon and in the rectum; this may be one of the factors which explains a selective localization.

AETIOLOGY

If one is to be absolutely accurate, a discussion on the origin of carcinoma of the colon might be dismissed with the comment that beyond one fact we know nothing with certainty about it. The single evidence which we possess is the indication that polyps become malignant, and even this statement is incomplete, because we are ignorant of the factors which initiate the polyp (*Figs.* 477, 478).

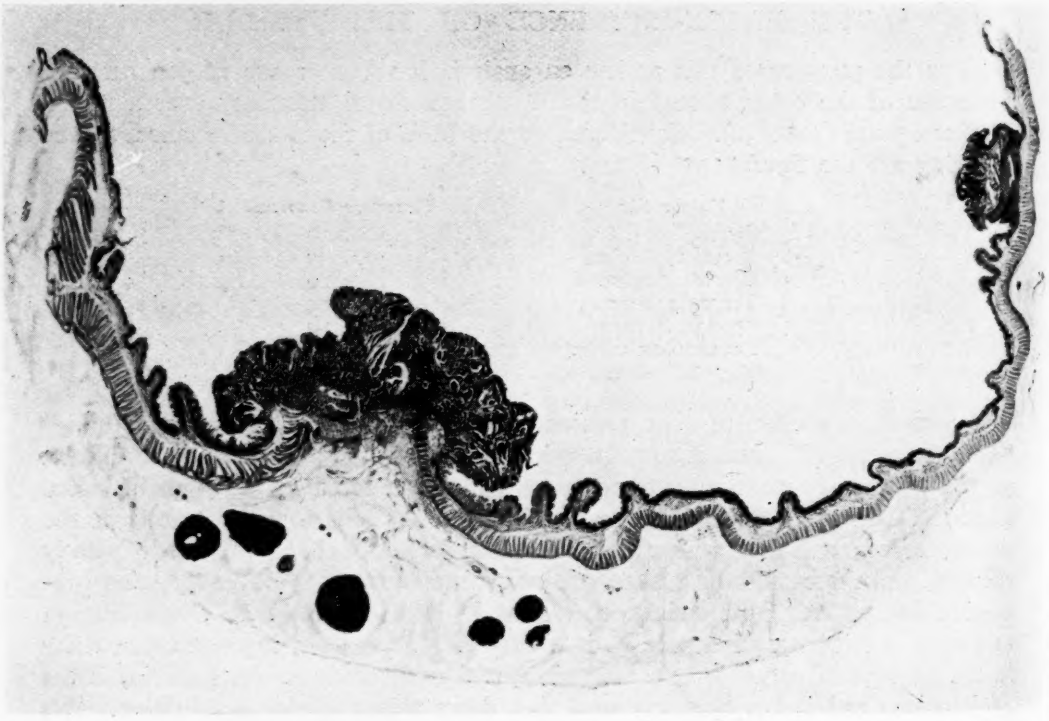


FIG. 477.—Simple and malignant polypi of the sigmoid colon. The small tumour on the right is simple, while the larger one on the left has undergone a malignant change.

Apart from this association it is difficult to find any evidence upon which as much as a hypothesis can be based. There appears to be no distinction in respect of sex; analyses by Clogg[15] and De Bovis[16] showed an almost equal distribution between males and females. The statistics of cases treated in the Edinburgh Royal Infirmary (613 in the period 1925–35) gave similar findings, the proportion being males 52 per cent and females 48 per cent.

Age considerations throw no light upon the problem; it is true that there is a peak period, and records agree that it falls in the decade between fifty and sixty years, but, on the other hand, age is no barrier, as there are many instances of malignant tumours of the colon occurring between 20 and 30 years of age and earlier. Six months ago the writer operated on a girl of 14 years for extensive carcinoma of the splenic flexure, and literature contains a number of records of a similar kind.

Such facts, interesting as they may be, are for the moment blind alleys, and we must continue to search for the predisposing and contributory causes. There is some factor which when brought into contact with the epithelium of the large

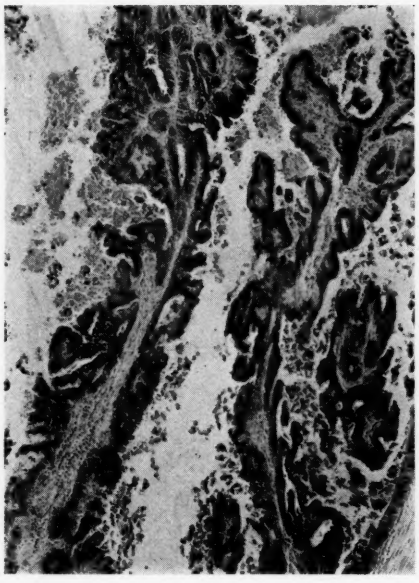


FIG. 478.—Polypi of the sigmoid colon which have become malignant.

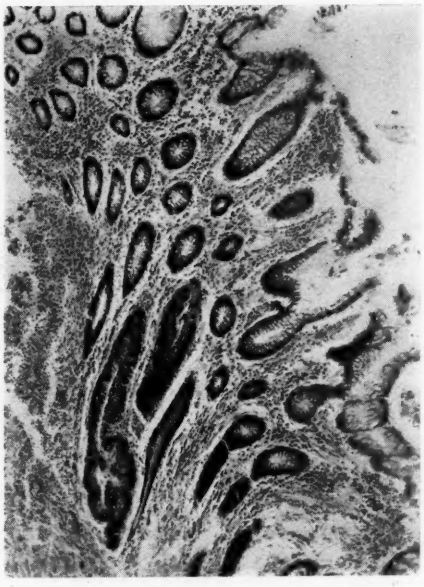


FIG. 479.—The early stage of colon carcinoma. Two acini are affected by the malignant change; the surrounding tissues are healthy.

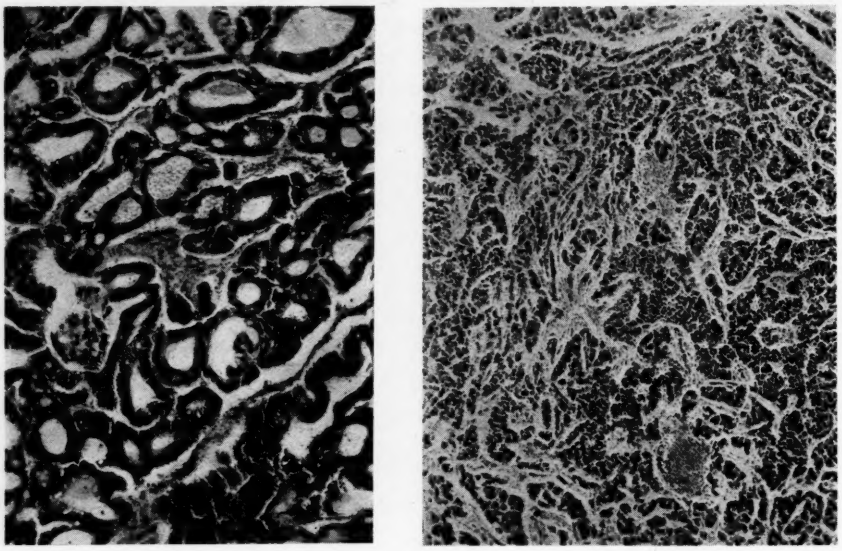
intestine initiates the process which we regard as a malignant change, but what that factor is remains a mystery—an irritant applied to a surface or conveyed to the epithelium by the blood or lymph currents; possibly something still more subtle, a deficiency in the factor or factors which control epithelial growth; or yet again a lymphœdema causing a disturbance of osmotic pressure, which in its turn disturbs the delicate process of nuclear division. There may be an attraction in indulging in hypotheses, but for the moment it is a futile exercise, and the truth is that, with the exception already quoted, we are ignorant of the origin of colon carcinoma.

PATHOLOGY

The adenocarcinoma is the distinctive malignant tumour of the colon. Tumours of a sarcomatous type are occasionally encountered, but their incidence is rare, and in so far as they represent a malignant change in mesoblastic tissue their occurrence in the large bowel is but an accident of position (Jopson and

White,[17] Corner and Fairbank[18]). Lymphosarcoma has its place in pathology, and its development in the lymph follicle of the bowel wall (Rankin and Chumley[19]) gives it a claim to be considered as a distinct bowel tumour. It extends in the submucous coat and infiltrates the wall of the bowel, though it rarely invades the serous covering. The submucous infiltration results in extensive and early ulceration, and this explains the urgency of the clinical features associated with the condition. The rapidity of the sarcomatous invasion produces tumefaction of relatively large areas of bowel, and the morbid anatomy is very different from that presented in carcinomatous lesions.

The characteristic tumour, then, is the adenocarcinoma. Its source is the epithelium which lines the bowel lumen, and the stigma of its malignancy is its



A B

FIG. 480.—The grading of large-intestine carcinoma. A, *Grade* I; B, *Grade* IV. *Grades* II and III represent proportional variations between these two extremes.

ability to invade the basement membrane, and to extend throughout the coats of the bowel wall. The early invasion is a microscopic phenomenon, and as it develops it encounters a tissue resistance in the shape of a barrier of lymphocytes (*Fig.* 479). It may be that microscopic invasions of this kind are the rule rather than the exception, but, if so, they fail through the opposition of the lymphocyte, and only in the unfortunate few do they survive to institute the focus of malignancy.

Let us follow the fate of the cell or cells that have achieved successfully this new and ominous phase of their life's history. They proliferate, and as they increase in numbers the tendency is to differentiate, that is to say, they become re-arranged on a plan which shows certain resemblances to normal structure. The distinctive and characteristic grouping is in the form of incomplete acini somewhat similar to that encountered in simple gland formation, and so they justify the description of adenocarcinoma, or, as estimated on a differentiated basis, of a

Grade I tumour (*Fig.* 480, A). In a small percentage of cases (and the percentage is very small) there is no attempt at differentiation; the cells accumulate in no particular order or arrangement, and to such an anaplastic state the pathologist subscribes the title of *Grade* IV (*Fig.* 480, B). Between the two extremes there are variations with a greater or lesser extent of acinar formation, and in virtue of this distinction there are *Grades* II and III. A conception of this kind, differentiation and non-differentiation, has a hypothetical basis, and when we come to apply it to carcinomata of the large bowel we find it difficult to draw sharp lines of distinction. In an individual tumour a single microscopic field suggests *Grade* I, while a second immediately adjacent suggests *Grade* IV, but, if we take a comprehensive view of the area, we find that *Grade* II is the reading in an overwhelming percentage of cases; that is to say, the bulk of the tumour is composed of differentiated acinar-grouped cells, while a small proportion is anaplastic and undifferentiated.

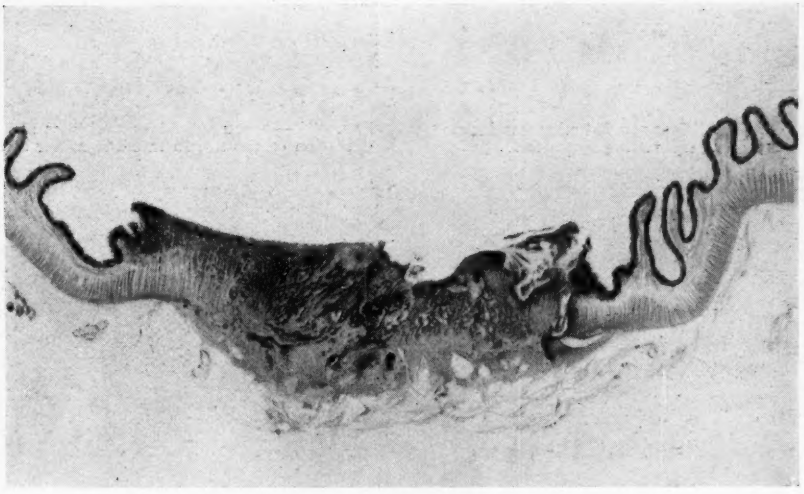


FIG. 481.—A diffuse mucoid carcinoma of the cæcum.

The invading cells may exhibit a further distinction. It is an indication of the source from which they have originated that under certain circumstances many of them produce mucin. It is probable that this product is present in a small amount in all carcinomata of the colon; if the proportion is obvious and considerable it is appropriate that the tumour should be termed a mucoid carcinoma. It is estimated that 5 per cent of carcinomata of the colon and rectum are of this type, and the areas in which they are encountered with greatest frequency are the cæcum and the lower end of the sigmoid colon, areas which, according to Harvey, have a larger proportion of mucin-producing cells than the other portions of the large bowel.

The disposition of the mucin varies; it may remain intracellular, distending the cell membrane and displacing the nucleus to one side (the signet-ring appearance), or it may be expelled from the cell to accumulate in the extra-cellular space. (*Figs.* 481, 482.)

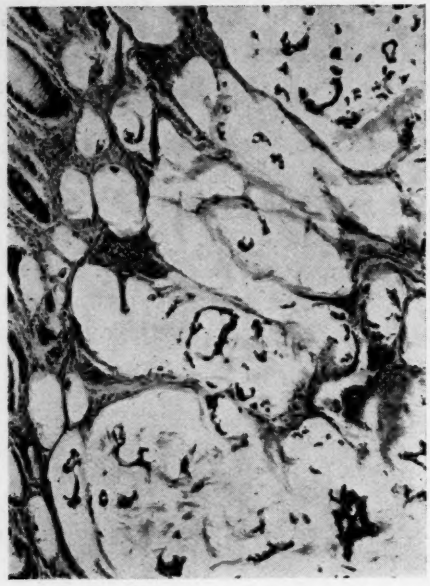


FIG. 482.—A diffuse mucoid adenocarcinoma showing signet-ring appearance.

FIG. 483.—A mucoid adenocarcinoma showing extrusion of the mucin into the acinar spaces.

FIG. 484.—A localized scirrhous type of adenocarcinoma of the ascending colon.

Mucin production is encountered in tumours of all grades, but it has been noted that intracellular mucin (signet-ring cells) are characteristic of the less differentiated tumour (*Grades* III and IV), while the extra-cellular accumulations are encountered in the differentiated (*Grades* I and II) tumour, showing acinar formation of the columnar epithelium. Parham[20] and Hayes[21] believe that the development of mucin appears to be associated with certain distinctive features in the progress of the tumour; that, though the primary growth is relatively slow, the tendency to recurrence once the regional lymph-nodes are invaded is most marked. These authors, and Parham in particular, claim that the signet-ring appearance indicates a high degree of malignancy, while the columnar-celled adenocarcinoma with mucin accumulated in the interior of the acinus is definitely less malignant (*Fig.* 483).

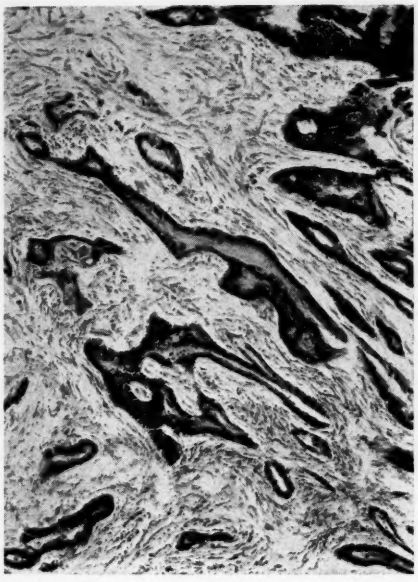


FIG. 485.—An adenocarcinoma showing a scirrhous reaction. The tumour is *Grade* III.

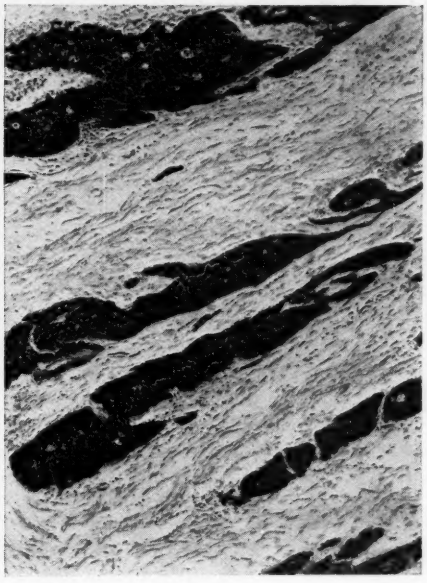


FIG. 486.—A scirrhotic or fibrous carcinoma of *Grade* IV.

Malignant-cell infiltration is associated with a varying degree of tissue reaction, and the future progress of the tumour is to some extent dependent upon the nature and degree of the reaction. The sources of the reaction are the lymphocytes and the reticulo-endothelial tissue of the bowel wall, and the ultimate sequel is the formation of fibrous tissue. In some instances the response is effective and complete, and the fibrous tissue formation fashions the growth into a scirrhous tumour which encircles the bowel wall and leads to narrowing of the lumen (*Figs.* 484–486); in other instances there is comparatively little tissue reaction, what there is constituting a reticulum which supports the tumour cells rather than impedes their progress, with the result that the tumour mass is bulky, and, following the lines of least resistance, extends into the lumen as a papilliferous or cauliflower-like growth (*Fig.* 487). The variability of this reaction, more than any other factor, may decide the clinical features of each individual case. According to the

gross and microscopic anatomy carcinomata of the colon are conveniently classified into three groups :—

1. Soft medullary adenocarcinoma ;
2. Scirrhotic or fibrous carcinoma ;
3. Mucoid carcinoma.

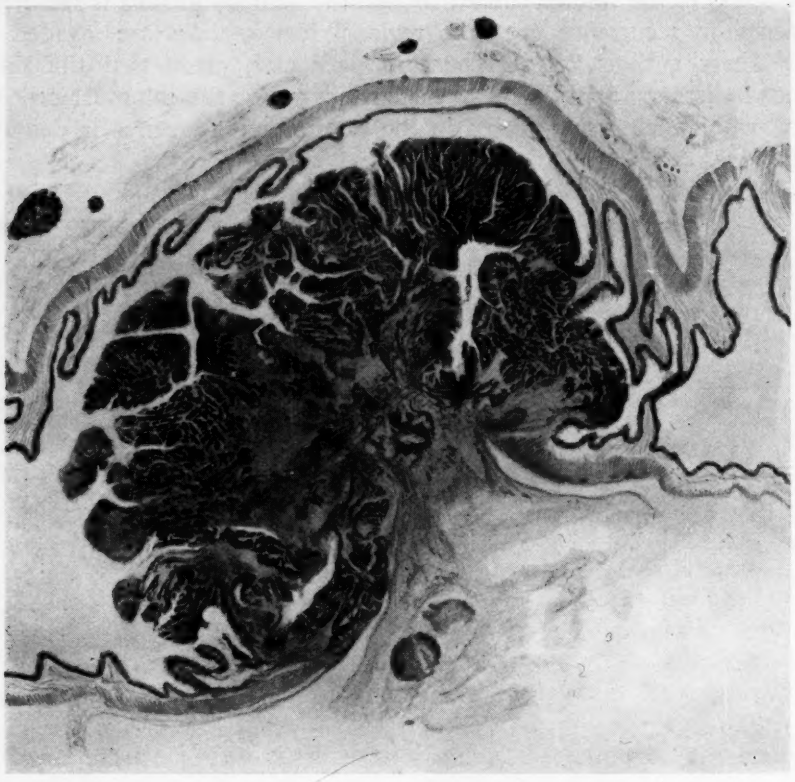


FIG. 487.—A papilliferous type of adenocarcinoma extending into the bowel lumen.

TUMOUR GRADING AND ITS SIGNIFICANCE

The system of tumour grading applied originally by Broders to malignant disease of the mouth has been extended to a variety of fields, particularly to tumours of the breast and of the rectum. Tumours of the colon have been studied in a similar way, but there are comparatively few accounts of investigation restricted to the large intestine proper (Rankin and Olsen[22]). The grading of carcinoma of the rectum has been studied by Rankin and Broders,[23] and by Dukes,[24, 25] and it may be supposed that the conclusions arrived at in relation to the rectum will be paralleled by the state of affairs in the colon generally.

Four tumour grades are recognized, and the presentations vary from *Grade* I, where differentiation is relatively complete and acinar formation constant, to *Grade* IV, which is frankly anaplastic and undifferentiated. *Grades* II and III occupy appropriate intermediate positions. Dukes, in his most recent paper, gives

the following grading estimate in rectal cancer: *Grade* I, 6 per cent; *Grade* II, 66 per cent (?); *Grade* III, 26 per cent; *Grade* IV, 2 per cent.

The proportion of *Grade* II has been queried because the actual figure is not given in the original paper, but, assuming that the standard is a percentage basis, the figure works out at 66 per cent for this group.

Grading has certain practical values apart from its cytological interest; it conveys an impression of the rate of growth of the tumour, and in relation to this it affords a standard upon which prognosis may be based, and in certain instances by which the type of treatment may be decided. Dukes' remarks on the prognosis association are most interesting. In the first five-year period the death-rate was as follows: *Grade* I, 40 per cent; *Grade* II, 56 per cent; *Grade* III, 76 per cent; *Grade* IV, 100 per cent.

Such readings may seem to afford a definite prognostic index, but Dukes has pointed out that another factor must be taken into consideration, the extent of spread at the time of operation, and so he grades rectal cancer on a morbid anatomy basis into three groups: *Group A*, Growth limited to wall of rectum; *Group B*, Extension to extra-rectal tissues, but no metastasis in regional lymph-nodes; *Group C*, Metastases in regional lymph-nodes.

On this basis a five-year period survival rate gave the following figures: *Group A*, 93 per cent; *Group B*, 65 per cent; *Group C*, 23 per cent.

Thereafter he correlated the tumour grades with the various groups, and he found " a great relative increase in the proportion of *A* (group) cases in *Grade* I, and a virtual disappearance of *A* (group) cases from *Grades* III and IV. On the other hand, the *C* (group) cases, which form a relatively small fraction of *Grade* I tumours, became the chief constituents of *Grades* III and IV and colloid." His ultimate conclusion was that the impressive difference in prognosis based on microscopical grading of the tumour might be interpreted on another basis—" that the anaplastic tumours are likely to have spread further than the better differentiated growths at the time when they receive surgical treatment ". To put the matter in another way, it is not the microscopical grade which decides the prognosis, but the extent of the tumour at the time of operation, though there is the corollary that the more anaplastic grades show the more rapid growth.

It may be argued that these considerations apply to tumours of the rectum, and that they should not be employed as an illustration of colon conditions. It is true that, until the grading of colon carcinomata has been studied more fully, we cannot assume an analogy, but it is likely that such exists, and that the basis which has been established for rectal carcinomata is applicable to tumours of the bowel at a higher level. The investigation which has been done on colon tumour grading seems to point to differentiation (*Grades* I and II) occurring in an overwhelming proportion, and this finding would be in keeping with the relatively good prognosis which applies in these cases.

THE CLINICAL HISTORY

Increasing attention is being paid to the importance of recognizing the early symptoms associated with large intestine carcinoma. It is appreciated that tumours of this type grow comparatively slowly, particularly *Grades* I and II, grades which comprise the bulk of tumours of this class. And yet against this we must put the

somewhat disconcerting fact that from 55 to 60 per cent of these cases are inoperable by the time that they come to operation (Koch[26] and Rosser[27]).

In this matter of the slow rate of growth of certain tumours Dixon[28] records an interesting experience. A man 48 years of age, who had complained for some months of diarrhœa and constipation, was found to be suffering from a carcinoma of the transverse colon; operation was advised, but refused. Two years later the patient returned complaining of obstructive symptoms. Operation revealed a tumour of the left half of the transverse colon adherent to the greater curvature of the stomach, but there were no signs of metastasis.

He goes on to say that in two instances he had resected the right half of the colon for tumours in which ileo-colostomy had been done three years previously; in each case the lymph-nodes were involved, but no metastasis was demonstrable. There is some comfort in these facts, but in another sense we should regard them as affording an opportunity for that early recognition of the disease by which the ultimate results would be so materially improved.

This is not the occasion to detail the variety of clinical features which may be associated with the disease, but it is opportune to draw attention to some general considerations.

The anomalous symptomatology has been commented on by Chiray and Rosanoff,[29] and they quote cases in which the early symptoms of the disease suggested conditions widely different from that which actually existed, appendicitis, abdominal tuberculosis, colitis, gall-stones, colic, and cystitis being simulated individually, dependent upon the situation of the colon tumour. It is an appropriate and necessary reminder, and it raises questions which must be debated in discussions on diagnosis; but what the clinician seeks is information of a constructive type in virtue of which his suspicions will be aroused, so that further investigation proceeds. The literature of the past ten years has been assembling a collection of facts which appear to indicate that carcinoma of the colon presents distinctive clinical pictures according to the segment involved.

Carcinoma of the cæcum and of the ascending colon present in their early stages a picture not unlike that associated with chronic appendicitis—indigestion, vague epigastric discomfort, and loss of appetite, evidences that are no doubt attributable to gastric disturbance, but which in a more essential sense are the reflexes of a disturbance centred in the cæcum and ascending colon. Several authors have drawn attention to the fact that this simulation of chronic appendicitis has led to a considerable percentage (15 to 18 per cent) of cases being operated on for appendicitis before the correct diagnosis was established (Priestly and Bargen[30] and Brindley[31]). As the tumour develops general weakness becomes evident, and a secondary anæmia appears. It is generally understood that these changes are coincident with ulceration of the tumour and absorption of toxic and bacterial products into the circulation. Whatever the explanation, they constitute a characteristic and striking clinical picture, and one which is regarded as distinctive of tumours of the cæcum and ascending colon. It is significant that in a certain percentage of cases there are no subjective symptoms, and the first recognition of the disease is when the patient or the doctor discovers a tumour. It may be said, therefore, that proximal colon tumours are apt to be associated with a curious anomaly of symptoms, and by reason of this there may be confusion of diagnosis and delay in the adoption of appropriate treatment.

Tumours of the mid or transverse colon present a more suggestive picture, and one which is likely to focus attention on the large bowel. Constipation, pain, and colic relieved by bowel movement are experienced in 80 per cent of cases, while diarrhœa is an inconstant evidence in 15 per cent (Rosser[27]). As might be anticipated from their relatively superficial position, transverse colon tumours are recognized by palpation at a comparatively early stage in 50 per cent of cases. (*Fig.* 488.)

Tumours of the descending colon and sigmoid colon are characterized by constipation and by blood in the stool, and it is estimated that these findings are encountered in 50 to 60 per cent of cases: diarrhœa occurs in some 20 per cent. (*Fig.* 489.)

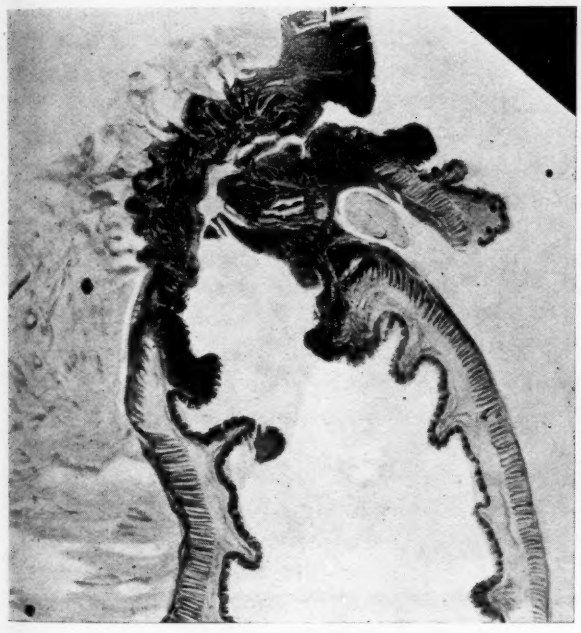


FIG. 488.—A scirrhous type of adenocarcinoma affecting the transverse colon and producing a relatively complete obstruction.

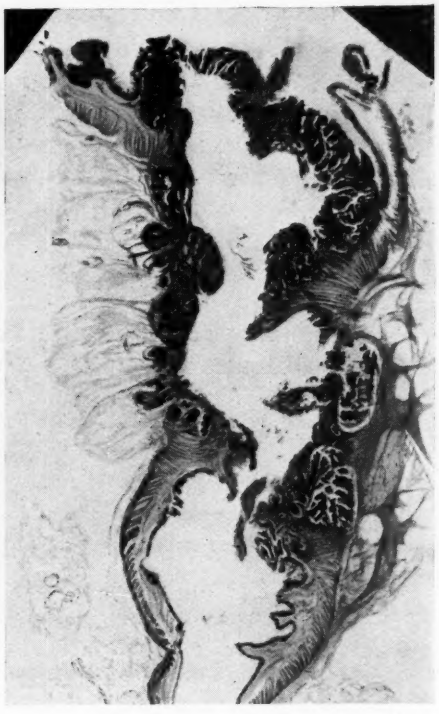


FIG. 489.—A diffuse ulcerating adenocarcinoma of the descending colon.

Rosser summarizes the position in an interesting way. He says, "A transition upwards is noted from right to left in four features, average duration of symptoms, constipation and colic, diarrhœa, and macroscopic bleeding. The following symptoms are highest in incidence on the right side, and decrease as the rectum is approached—anæmia, indigestion, localized pain (not relieved by bowel movement), and palpable tumours."

DIAGNOSIS

In introducing the subject of diagnosis one cannot do better than repeat a recent statement of E. L. Young[32] to the effect that "it should be emphatically stated and reiterated again and again that any change, however slight, in the

normal bowel behaviour of any individual without any known cause, particularly in the cancer age, persisting for more than a few days after adequate treatment is started, should demand the most painstaking investigation".

It is evident that the first link in the chain of diagnosis is a personal matter, implying a departure from a former state of good health. It may suggest a disturbance of bowel function, but there are the more insidious possibilities when weakness and anæmia and a decline of general well-being are the features that arouse suspicion. It is really a matter of education, this early and so important stage, and it cannot be too fully appreciated by the laity and the profession alike that a decline from a previous condition of health demands a most careful and detailed

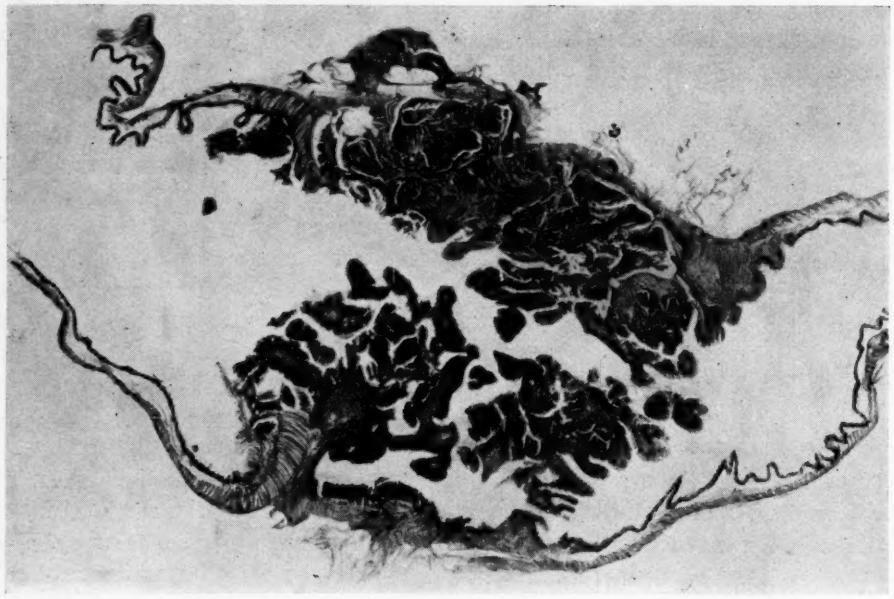


FIG. 490.—A malignant papillomatous tumour of the cæcum.

investigation of the circumstances responsible for the decline. The general practitioner is the second link, and in some respects the most vital of the series. His training will remind him of the possible significance of the symptomatology, and he will do well to keep in mind the obscurity of proximal colon lesions. The probability is that he will not take too serious a view at the beginning, and will recommend some simple remedies in the form of drugs and diet, but, if he is a man of understanding and experience, he will warn his patient that, if there is not an early and complete response to these, there must be no further delay in arranging a more detailed investigation. It sometimes happens that the practitioner makes a provisional diagnosis when his abdominal examination reveals the presence of a tumour. The specialist and his coadjutors constitute the third link, and upon them the responsibility devolves of supplying the final diagnosis. The surgeon will interpret the significance of the symptoms, and he will explore the physical evidence that is revealed by abdominal examination, by sigmoidoscopy, and by investigation of the stools. In the last issue the X-ray examination is the sovereign means by

which the diagnosis is confirmed or negatived; its value is beyond question, but there are situations in which it presents difficulties and pitfalls. There is the question whether preference should be given to the barium meal or the barium enema; the consensus of opinion favours the latter for the reason that in the large bowel it affords the most accurate orientation, while the meal has two serious objections—it may precipitate obstruction, and it may confuse the diagnosis when the voluminous barium-filled proximal loop overlies the tumour area. It is pointed out that the accuracy of the barium enema is at fault in 10 per cent of cases (Crafoord[33] and Young[32]), and therefore it should be repeated when the clinical examination affords suggestive evidence. Lesions of the cæcum are those most likely to be overlooked (Dixon[28]). (*Fig.* 490.)

The technique is a matter which concerns the radiologist; screening and palpatory manipulation aid the localization of the tumour, and the Fischer technique (inflation with air after partial evacuation of the opaque enema) enhances the diagnostic accuracy (Gordon-Watson[34]).

And what of the efficiency of the method as a medium of diagnosis? Weber in 1929, in the Section of Roentgenology of the Mayo Clinic, made a correct diagnosis in 99 of 102 organic lesions of the large bowel above the middle of the sigmoid flexure (Rankin, Bargen, and Buie[35]). That improvement in technique has increased the reliability of barium enema investigation is asserted by many reporters. Petren[36] recorded 25 per cent of errors in 1928, while Flemming Møller[37] stated in 1934 that the percentage of error was then 7 per cent.

TREATMENT

It has been said that when the treatment of a case of carcinoma of the colon is under discussion it is advisable to settle the preliminary question—what is the position in respect of obstruction? And in answering the question, three possibilities are envisaged: (1) The non-obstructive case; (2) The case demonstrating chronic obstruction of a mild degree; (3) The chronic obstruction case which threatens to become acute.

Treatment considerations present different problems in each possibility.

1. The Non-Obstructed Case.—

a. PRE-OPERATIVE CARE.—There is universal agreement that three to four days should be spent in preparatory treatment. The diet is one which is low in protein and high in carbohydrates, and fluids are given in abundance. Laxatives should be of a mild type, and sodium phosphate is a favourite choice.

The risks of peritoneal infection subsequent to the operation are recognized, and many surgeons adopt procedures which in their opinion minimize this danger. Young[32] injects intraperitoneally 100 c.c. of amniotic fluid three days before, and a further injection of 100 c.c. one day before, operation. He believes that the fluid increases the resistance of the peritoneum. Wakeley[38] employs a mixed vaccine (enterofagos), one ampoule being injected intramuscularly twice daily for a week prior to operation. The most popular of such precautions, however, is the intraperitoneal injection of a mixed streptococcal and *B. coli* vaccine. Dixon[28] uses a preparation, 1 c.c. of which contains about half a billion of each type of organism. One c.c. is diluted in 10 c.c. of physiological saline solution, and this amount is injected intraperitoneally into the right or left lower quadrant according

to the area of the operation. Its maximum effect is reached in forty hours, when the large mononuclear cells or histocytes of the peritoneal fluid show a marked increase. Dixon has used this procedure since 1928; his mortality figures have improved by 66 per cent, and he attributes the improvement in large measure to the vaccine. Many surgeons are enthusiastic on this point, but there are others who are sceptical. The views of F. W. Rankin[39] are interesting. In 1934 he acclaimed its value, and he attributed an improvement in mortality figures from 22·4 per cent to 4·9 per cent partly to its influence, but in 1936[40] he stated that he had abandoned the method because in a series of 130 patients on whom he had performed 200 consecutive operations without the preliminary use of intraperitoneal vaccine the mortality was lower than in a similar series of cases in which the vaccine had been employed.

If there is evidence of anæmia, a pre-operative blood transfusion is given, and this finding is so constant in association with cæcal tumours that transfusion has become a routine procedure.

b. THE TYPE OF OPERATION.—There is general acceptance of the fact that different sections of the colon demand distinctive types of operation when removal of a tumour is demanded. If the disease occurs in that section of the colon which extends from the cæcum to the right half of the transverse colon a one-stage resection completed by an ileo-transversostomy is generally chosen; beyond this point up to the level of the mid-sigmoid area two-stage procedures of the Mikulicz or Rankin type are favoured; in the most distal segment, the lower portion of the sigmoid and the sigmoido-rectal junction, opinion on the most suitable type of operation is divided, and the peculiar difficulties of the situation are such that no uniformity of plan has yet been reached.

A search of the recent literature indicates that opinion is virtually unanimous on the value and relative safety of the one-stage resection and ileo-transversostomy operation for *tumours involving the proximal colon*, assuming that they are of the non-obstructed type. The advantages are obvious; apart from the satisfaction of completing the procedure in one stage, the operation permits a radical extirpation of the lymph-bearing field, and, by the union of the lower end of the ileum to the left half of the transverse colon, it ensures a satisfactory anastomosis in fields of assured vascularity. It is true that there are some who prefer a course which they regard as offering an even greater measure of security, and they complete the ileo-transversostomy as a preliminary measure, and subsequently remove the tumour (Wakeley[38]), or they remove the tumour-bearing area on the Mikulicz plan, ensuring a long spur between the lower end of the ileum and the transverse colon (Devine[41]). It is possible that these methods ensure a diminished immediate risk, but it is evident that in the later stages complications may arise which are avoided in the single-stage operation. It seems as though statistics might be valuable in assessing the safety index of the different methods, but it is apparent how misleading it may be to rely on figures unless they are most carefully and conscientiously controlled.

Tumours of the distal colon, i.e., from the left half of the transverse colon to the middle of the sigmoid loop, are being dealt with to an increasing extent by the mobilization and two-stage resection methods. Rankin[42] stated in a recent paper that he had definitely abandoned immediate resection and end-to-end anastomosis as a primary operation for tumours of the left colon, the risks being too high. There are many who think as he does, and the decision has been forced

upon surgeons in an attempt to improve mortality figures. Insecurity of blood-supply, the difficulties of efficient mobilization, and the ever present risk of sepsis are the factors that have prejudiced the issue. Two-stage resections give a large margin of safety, but they possess a serious disadvantage—they rarely permit an efficient eradication of the lymph-bearing field, and yet they appear to offer the best solution of the problem. Devine[41] continues to employ resection and end-to-end anastomosis in left colon tumour, but he does so with precautions. By means of a two-opening transverse colostomy he secures dysfunction of the bowel beyond. Thereafter some weeks are spent in rendering the dissociated segment as free from infection as possible, and ultimately the resection and anastomosis are carried out in a field which he claims to be relatively sterile.

Tumours of the lower sigmoid and sigmoido-rectal junction continue to provide a difficult problem, and no operation that is capable of universal application is likely to be evolved; each case must be decided on its own merits. Rayner[43] has given an interesting review of the peculiar difficulties of this situation and of the modes by which these difficulties have been overcome. He mentions four types of operation: (i) Abdomino-perineal excision; (ii) Abdomino-anal excision retaining the sphincters; (iii) Intraperitoneal excision with closure of the stump of the rectum and a permanent colostomy; (iv) Rutherford-Morison's operation—end-to-end union over a wide-bore rubber tube.

2. The Case Demonstrating Chronic Obstruction of a Mild Degree.—It is appreciated that, if any degree of obstruction exists, resection and immediate anastomosis should be avoided whatever the situation of the tumour. In proximal colon lesions, if the ileocæcal valve continues to function, a decompression may be secured by an ileo-transversostomy, and it appears that this can be accomplished without undue risk. In other situations the choice lies between a decompression at a higher level, with subsequent resection, or an immediate resection on the Mikulicz plan, so that adequate lumen drainage is secured.

3. The Chronic Obstruction Case which Threatens to Become Acute.—In this instance decompression of the obstructed segment is the urgent and immediate necessity, and there is no doubt that cæcostomy is a most valuable operation under such circumstances. It ensures that gradual decompression which is so essential if complications are to be minimized, it affords the margin of security while further investigations regarding the position and extent of the tumour are proceeding, and it does not prejudice the future conduct of the case in the way which a colostomy is apt to do.

PROGNOSIS AND RESULTS

General and Local Factors in Relation to Prognosis.—Many factors influence the prognosis, and in a review of this description one can but touch upon certain individual features.

Taking the general and local conditions apart from questions of operation, there are the considerations of age and general condition of the patient, and the duration of the disease before surgical attention was secured. The bearing of these features is obvious.

SITUATION OF THE TUMOUR.—This is of importance. *Cæcal tumours* grow moderately quickly, and their association with a deterioration of the blood produces a

significant complication; *transverse colon tumours* imply the possibility of a widespread lymphatic dissemination; *distal colon tumours* grow relatively slowly, but the scirrhous character which they so often display implies an early invasion of the lymph areas; *tumours of the lower sigmoid and sigmoido-rectal junction* have their peculiar risks and dangers on account of the difficulties associated with their removal.

LOCAL EXTENT OF THE TUMOUR.—This has great significance in the prognosis, and, if a system of grading were adopted on a morbid anatomy basis similar to that employed by Dukes in carcinoma of the rectum, a valuable prognosis index might be available. On such a basis five grades would be recognized:—

1. Tumours restricted to mucous membrane and submucous coats.
2. Infiltration up to but not including the serous coat.
3. Involvement of the peritoneum.
4. Invasion of gland elements.
5. Extension to adjacent tissues.

MICROSCOPIC GRADING as an aid to prognosis has already been alluded to.

Prognosis in Relation to Operation.—It is difficult to review the operation prognosis in the form of a summary, but the purpose may be met in part by quoting certain tables from Fredric Koch's[26] recent article in the *Archiv für klinische Chirurgie*.

Table I gives an impression of the mortality rates in different clinics. It is understood, of course, that they represent a variety of operative procedures, but

Table I.—THE RESULTS OF RADICAL OPERATION (VARIOUS METHODS)

SURGEON	YEAR	NO. OF CASES	DIED	PERCENTAGE MORTALITY
Nordmann	1926	34	7	20·5
Turner	1929	142	27	19
Schloffer	1930	104	24	24
Haberer	1931	172	43	25
Finsterer	1931	76	19	25
Guleke	1932	41	11	26·8
Krecke	1932	100	27	27
Wilkie	1934	101	15	15

Table II.—THE RESULTS OF PRIMARY RESECTION

SURGEON	YEAR	NO. OF CASES	DIED	PERCENTAGE MORTALITY
Nordmann	1926	26	5	19
Turner	1929	70	—	25·7
Schloffer	1930	48	11	23
Haberer	1931	—	—	26
Finsterer	1931	39	9	34·3
Guleke	1932	31	8	25·8
Krecke	1932	33	13	40
Wilkie	1934	38	5	13
Jacobsson	1934	17	3	17·6
Lofberg	1935	42	7	16·6

the universal standard has been removal of the tumour by whatever method was thought to offer the best results. The table represents a total of 770 cases, with an average mortality of 22·5 per cent.

In relation to primary resection Koch gives the figures shown in *Table II*, which records an average mortality of 23·1 per cent in a total of 344 cases.

There is an impression that mortality in left colon operations exceeds that on the right side. The statistics bearing on this point are few, but what there are appear to support the contention. Miller[44] came to this conclusion in respect of 129 cases, and Rankin[45] gives the following comparative figures :—

150 right colon resections with an operative mortality of 12·0 per cent
330 left colon resections with an operative mortality of 16·2 per cent

The Effect of Ileus on Mortality.—Statistics indicate that a pre-existing ileus has a profound effect upon operative mortality figures. In Koch's series of 116 cases 38 were complicated by ileus, and, while the operative mortality in uncomplicated cases was 16·6 per cent, the death-rate in the ileus group reached 60 per cent. It is noteworthy that left colon tumours are associated with obstructive features to a much greater degree than is the case on the right side, the proportion being roughly 2 to 1, and this fact must play a part in exaggerating the seriousness of left colon operations.

The Causes of Early Post-Operative Death.—An analysis of case records culled from various sources indicates that when death occurs within a period of ten days following primary resection and anastomosis, 85 per cent of the cases succumb as the result of a peritonitis spreading from the region of the anastomosis. The remaining 15 per cent mortality is attributable to causes which may be associated with any serious operative procedure—embolism, bronchopneumonia, and heart failure. The risks of anastomotic infection are therefore considerable; they are no doubt exaggerated in certain instances by insufficiency of the blood-supply, but essentially they depend upon the fact that the surgeon is working in a highly infected area, and one which it is impossible to render aseptic in any degree. Aseptic anastomosis by one or other of the various techniques which have been described seems to offer a means by which the risks may be lessened, and it may be that in the future these methods will receive further consideration.

The Ultimate Life Prognosis.—This estimate has been made the subject of many interesting and encouraging records. To take one such, Rankin and Olsen,[22] in an analysis of 453 cases, reported that right colon tumours furnished a five-year cure in 57·6 per cent of cases, while left colon tumours afforded a cure in the same period in 47·7 per cent. These are encouraging figures, and they appear to indicate that with reasonably early diagnosis and sufficiently radical extirpation of the tumour-bearing area and its associated tissues the proportion of permanent cures is considerable.

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VISITS TO SURGICAL CLINICS AT HOME AND ABROAD

THE MAYO CLINIC, ROCHESTER, Minn.

THE growth and development of the Mayo Clinic is one of the romances of medicine. In 1845 a young English chemist, William Worrall Mayo, emigrated to the United States and settled in New York, where for some years he taught physics and chemistry. Moving later to Indiana, he commenced the study of medicine, and eventually qualified at the University of Missouri in 1854. After serving in the Civil War as a surgeon, he came to live in the small town of Rochester, in the State of Minnesota, where his abilities as a doctor were soon recognized.

In 1883, however, something occurred which, in the light of subsequent events, was to have a profound effect on the work of Dr. Mayo and his two sons. In that year a cyclone passed over the small town, and a large number of people were killed and injured. There was no hospital to deal with the casualties, and the responsibility for the care of the sick and injured fell on the shoulders of Dr. Mayo. Some years later, and it can be said almost certainly as the result of the unfortunate experience of 1883, a small forty-bed hospital was built by the Order of St. Francis, under the direction of Dr. Mayo and his two sons—Drs. William and Charles Mayo. From this humble beginning, therefore, has developed what is now the world-famous Mayo Clinic.

Just as a stranger visiting Oxford or Cambridge for the first time senses at once the University atmosphere, so does one in Rochester realize that this is the Mayo Clinic. The Clinic itself in the centre of the town, towering over the surrounding buildings; hotels full of convalescent patients and their relatives; the uniformed nurses hurrying to and from the various hospitals—all leave the visitor in no doubt as to where he is. Even a part of one of the leading hotels has been converted into a temporary hospital!

The present Clinic building, opened in 1929 on the site of Dr. Mayo's original home, is a fine imposing structure situated in the middle of the town (*Fig.* 491). It is purely a diagnostic centre, as practically all treatment is carried out at one or other of the affiliated hospitals. With its numerous consulting rooms, laboratories, and various departments for special investigation, the organization is such that large numbers of patients can be seen and completely investigated in a short space of time, and therein lies the success of the Clinic.

On the ground floor, adjoining the magnificent entrance hall, is the Registration Department (*Fig.* 492), with the Records Department below (*Fig.* 493). Above, on the main floors, are the Diagnostic Sections, as they are called, and it is here that the patients are sent for registration. Each Section consists of a large, comfortably furnished waiting hall, with numerous examination rooms opening off.

At the top of the building is a well-appointed library (*Fig.* 494), and the editorial and photographic sections. Then there are the usual biochemical laboratories, and various other special departments; but of particular interest are the gastric analysis and B.M.R. rooms, especially the former. Gastric analysis is obviously regarded as an essential step in the general routine investigation of patients at the

FIG. 491.—The Mayo Clinic.

Clinic, and the picture of a large room with cubicles occupied by patients in the various stages of test-meal investigation is one that is not easily forgotten.

The Pathological Museum is in a separate building opposite the Clinic, and is unique in many respects. One interesting feature is the series of wax models depicting the stages of certain operations, and one felt that, from the point of view of the student, here was the ideal method of instruction in operative surgery. The

FIG. 492.—Registration Department, Mayo Clinic.

FIG. 493.—Corner of Records Department, Mayo Clinic, showing the shutes in operation.

models illustrating the steps of a thyroidectomy were particularly realistic; but they are all superb and Tussaud-like in execution. The various specimens are beautifully prepared and mounted.

What perhaps impressed the visitor most of all was the extraordinary efficiency of the Records Department. Here the filing of case-histories and records has been reduced to a fine art, and we spent a very profitable afternoon being shown the various systems used in the department. There is one machine alone which can sort history cards at the rate of 400 per minute, or 24,000 per hour. This is done by a complicated system of coded slots on the cards, each slot representing some special disease or condition, and when it is remembered that there are close on

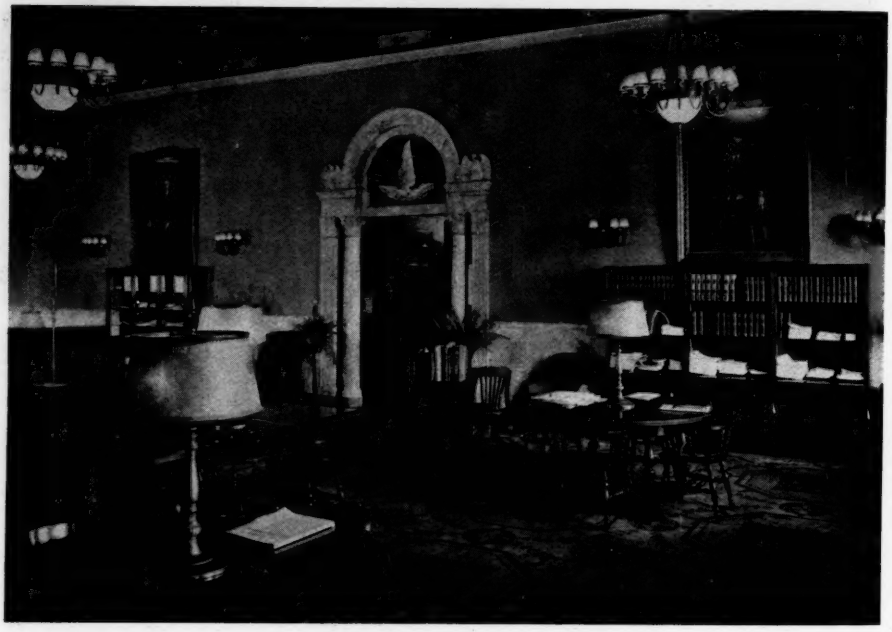

FIG. 494.—A corner of the Library, Mayo Clinic.

one million case-histories in the department, the comparative ease with which it is possible to collect the records of any particular condition is obvious. Between the departments and each of the outside hospitals there is a series of shutes by which the files can be sent from one to the other at a moment's notice.

As in the Out-patients Departments of our own hospitals, every patient must register on arrival at the Clinic. After this formality has been complied with, the patient's subsequent course varies according to whether he has been recommended to some particular member of the staff by his own doctor or whether he has arrived without any letter of introduction. In the former case, he is sent direct to the consultant concerned, but, generally speaking, every patient is at first assigned to one of the general diagnostic sections, where an appointment is made for him to see the consultant on duty. The consultant, with his first assistant, takes a careful history of the case, followed by a detailed examination, and when this is completed, the clinical findings are fully discussed. It may be found necessary to send the patient to one or more of the special sections for further

investigation, and when these examinations are complete, he returns to the original consultant, who decides upon the requisite treatment, if any. If the case turns out to be surgical, then one of the surgeons is called in consultation, and he directs the subsequent treatment.

Every patient visiting the Mayo Clinic for the first time is subjected to several routine examinations, no matter how obvious and trivial his complaint may be. This may appear in many cases to be an unnecessary formality, and one questions whether in this country patients would be as eager and willing to submit to such investigations as they are in the United States. The compulsory tests are a complete blood-count, including the Wassermann reaction, and a full urinary analysis. In addition, radiographs of the lungs are taken in a large number of cases, and particularly in those where an anæsthetic is contemplated. There is much to be said for these routine procedures, and the Clinic Staff rightly claim that the advantages derived from them more than justify their wholesale adoption. As was pointed out, a condition such as recrudescence of quiescent tubercle, following the administration of a general anæsthetic, is almost unknown at the Clinic.

The work of the surgical staff of the Clinic is divided between the outside hospitals and the Clinic itself. Operative work and treatment is carried out in St. Mary's Hospital, run by the Order of St. Francis, and in the group of hospitals managed by the Kahler Corporation, these institutions having between them about 1400 beds. Each surgeon on the staff attends the Clinic on certain mornings and afternoons for the purpose of seeing cases which need a surgical opinion. He is the surgeon on duty, and as such is at the call of all the various consultants who may be working at the time; consequently, in such a large building it is essential that there should be some system whereby he can be found with the minimum of delay. By an ingenious arrangement of coloured lights and signals, this problem has been effectively solved, and one was much impressed by the ease and rapidity with which any particular consultant was located.

Staff meetings are held on every Wednesday evening, when short papers are read and other items of medical and surgical interest reported. In addition, those cases in which there has been a fatal issue are fully investigated and openly discussed. First of all the pathologist gives his report on the autopsy findings; then the physician originally in charge of the case gives the result of his investigations; and he is followed by the surgeon (if there has been an operation) indicating what he found, the procedure he adopted, and his reasons for doing so. The discussion which follows between the members of the staff in such a case is most stimulating. If there is cause for criticism in the handling of the case, this is openly made, and suggestions put forward for the treatment of a similar condition in the future. Altogether, one could not help feeling that a more universal adoption of this type of critical review would be of great value.

The experimental research department, or, as it is called, the Institute of Experimental Medicine, is situated a few miles from the town. Here every facility is provided for experimental surgery, and the laboratories are singularly well equipped. The Institute is unique in one respect, in that, in addition to the medical men, there is a staff of veterinary surgeons engaged in their own particular line of research.

As has already been mentioned, the hospital work of the Clinic is spread over five institutions, four of which—the Colonial (*Fig.* 495), Kahler, Worrall, and

Curie—are under the control of the Kahler Corporation, while the remaining one—St. Mary's—is the direct descendant of the original hospital built in 1889. As a rule the general medical and surgical cases are treated at the Colonial, Kahler, and St. Mary's Hospitals, while the special departments are established at the others. The general lay-out and equipment of these hospitals are very similar to our own, with the exception that as all patients are paying ones there is a much larger proportion of single- and three- or four-bed rooms.

Operations commence at 8 a.m. and 1.30 p.m., according to the hospital. At St. Mary's the surgeons work invariably with two theatres and two teams of assistants. While the surgeon is finishing his first case, one of his assistants is

FIG. 495.—The Colonial Hospital, with the Mayo Clinic on the left.

opening the abdomen of the second in the adjoining theatre, and it is remarkable how quickly a list of formidable operations is performed in this way. Apart from this team work, there is nothing very unusual in the general theatre technique. It was a little strange, perhaps, to see the nurses administer anæsthetics, but, in fairness, let it be said that they are extremely efficient.

Iodine does not seem to be a popular skin application, merthiolate being used for practically every case.

As regards post-operative treatment, one was impressed by the frequency of the use of oxygen tents, of which there seemed to be an almost unlimited supply. One surgeon, in particular, applies this form of treatment routinely in cases in which shock is anticipated. Patients are placed in a tent for twenty-four hours or so, and there is no doubt about their general condition being materially improved. In addition, blood transfusion is frequently resorted to, and there is apparently no difficulty in obtaining large numbers of suitable donors.

OPERATIONS WITNESSED

1. Dr. Waltman Walters, at St. Mary's Hospital.—

PARTIAL GASTRECTOMY.—

Case History.—Male, aged 39, with a history of a perforated duodenal ulcer on two occasions and recurrent attacks of hæmatemesis.

Anæsthetic.—Novocain block to abdominal wall, and open nitrous oxide and ether.

Operation.—Right paramedian incision. Gastro-hepatic and gastro-colic ligaments separated from the stomach. After ligature of the coronary vessels, the stomach was divided high up between clamps and the distal portion retracted to display the duodenum more easily. The duodenum was then divided and the distal end closed in three layers. Anastomosis was performed between the proximal portion of the stomach and the jejunum, after the method of Polya.

Dr. Walters uses both catgut and silk in his anastomotic work, the former for the inner layers and the latter for the outer.

2. Dr. De J. Pemberton, at the Kahler Hospital.—

ABDOMINAL-PERINEAL EXCISION OF THE RECTUM.—

Case History.—Male, aged 65. Preliminary colostomy three weeks previously.

Anæsthetic.—Spinal.

Operation.—Sub-umbilical midline incision. Sigmoid flexure divided below the colostomy with cautery. The proximal end was closed and the stump of bowel covered with cellophane. Mesocolon divided and vessels secured. The lateral incisions along the mesentery were continued and the peritoneum reflected. The bowel was then separated from the sacrum behind, the peritoneal flaps sutured over it and the abdomen closed.

For the second part of the operation the patient was not moved. Dr. Pemberton feels that this is an important point in the operation, and it is his opinion that shock is much less marked when this procedure is carried out.

The legs having been placed in a lithotomy position, the anus was closed, and the loop of bowel removed through the perineum in the usual way. The perineal wound was packed with gauze.

The complete operation lasted for sixty-five minutes.

3. Dr. G. J. Thompson, at the Colonial Hospital.—

TRANS-URETHRAL PROSTATIC RESECTION BY THE 'PUNCH' METHOD.—

Anæsthetic.—Spinal.

Operation.—This operation is undoubtedly a remarkable one. Several cases of enlarged prostate were treated, in all of which the gland was completely removed. The operation was performed with Dr. Thompson's own special direct vision instrument, which enables the prostate to be punched out in small pieces. Hæmostasis is secured by the frequent application of a coagulating diathermy electrode, and the operation is completed by the insertion of a large catheter. We had several opportunities of viewing the prostatic cavity after the operation, and there was no doubt that the prostate had been completely removed.

This operation is a difficult one to perform, demanding a high degree of technical skill, and it is questionable whether it should be adopted by other than an expert operative cystoscopist.

Dr. Thompson assured us that he rarely had trouble with post-operative hæmorrhage. The average length of stay in hospital is only seven to eight days, and the success and popularity of this operation may be judged from the fact that only one suprapubic prostatectomy was performed in the Clinic during the previous twelve months.

4. Dr. J. G. Love, at St. Mary's Hospital.—

EXTENSIVE SYMPATHECTOMY FOR ESSENTIAL HYPERTENSION.—

Case History.—Female, aged 51, with a marked vasospastic element, as determined by special test.

Anæsthetic.—Nitrous oxide, ether, and oxygen.

Operation.—Combined dorso-lumbar incision on the right side. Twelfth rib resected, and pleura and lung exposed. Crus of diaphragm defined by working over the quadratus and psoas major and minor muscles. Three splanchnic nerves resected and the first two lumbar ganglia. Operation completed by decapsulation of the adrenal.

Altogether, the visit to the Mayo Clinic was most enjoyable, and many lessons could be learned from a study of its methods. The routine examination, close attention to detail, thoroughness of preliminary investigation, and post-operative care, are merely examples of the ordinary ritual in force at the Clinic. That the Clinic is a triumph of organization, few will deny; and that it justifies its high position in the medical world all who have visited it will agree.

EXPERIMENTAL SURGERY

INTESTINAL STRANGULATION

THE DEPRESSOR PROPERTIES OF THE PERITONEAL TRANSUDATE IN INTESTINAL STRANGULATION

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INTRODUCTION

Death from intestinal strangulation has been attributed to many causes. Fluid loss into the strangulated loop and peritoneal cavity, and absorption of depressor toxins formed in the strangulated segment of bowel, have been advanced as the chief causes in recent years; the nervous factor has not yet been reported upon. Knight and Slome (1936) reported the presence of a toxic depressor substance or substances in the peritoneal fluid, thoracic-duct lymph, and mesenteric venous blood of cats dying of venous strangulation of the small intestine, which produced "a characteristic and permanent depression of blood-pressure corresponding to the clinical picture of strangulation". To this substance or substances they attributed an important role in producing the lethal outcome of strangulation of the intestine; but they emphasized that accessory factors, other than the depressor substance, were also contributory causes of death. Foremost amongst these they placed nervous effects caused by the distension of the intestine, and especially rhythmic alteration in the degree of distension such as occurs in the course of peristalsis. Loss of fluid volume from the circulation, on the other hand, when the loop was small, was shown by them to be unimportant. Two conditions were stated which any lethal factor must fulfil in order to account for the rapid collapse in severe cases of intestinal strangulation. The first was potential rapidity of action, and this, they claim, was fulfilled by the fact that the contents of the strangulated loop had a depressor action upon the blood-pressure when extracted from the loop within from 30 to 70 minutes, the peritoneal fluid within one hour, and the thoracic-duct lymph within from 40 to 70 minutes, of strangulation. The second was that the lethal factor should be capable of producing in the normal animal effects similar to those in an animal whose gut has been strangulated.

The degree of depressor activity was gauged by the effect on the blood-pressure of a normal cat of intravenous injections of peritoneal fluid, mesenteric venous blood, and thoracic-duct lymph in various amounts. This fluid produced an acute fall of blood-pressure, following which the pressure rose either to the former resting level or remained "stable at a permanently lower level". Occasionally, during the recovery phase, irregularities of the heart beat were observed; it was suggested that these were perhaps caused by some direct action of the injected fluid upon the heart muscle. However, such irregularities frequently

occur after the injection of small quantities of histamine and acetylcholine into cats with a high blood-pressure (such as is seen when chloralose is used as an anæsthetic). The significance of the stabilization of blood-pressure "at a permanently lower level" is doubtful, because this may occasionally occur after the injection of small quantities of histamine, which in themselves have no permanent deleterious effect upon the animal.

In order to attribute to the peritoneal fluid depressor properties sufficiently powerful to play a principal part in causing the collapse of the circulation seen in intestinal strangulation, it is, as Knight and Slome state, necessary to prove that the transudate is capable of producing in the normal animal effects similar to those observed in an animal with strangulated intestine. If the peritoneal transudate does contain a potent depressor substance or substances which are entirely or largely responsible for the fatal result, injection of the transudate in large quantities, either intravenously or intraperitoneally, into normal animals should either kill, or markedly lower the blood-pressure over a period of several hours.

There is no doubt, however, that the peritoneal transudate is toxic, for if the strangulated segment of small intestine is placed in a rubber bag, so that the fluid transuded from it is shut off from the peritoneal cavity, and absorption is, accordingly, delayed, death is also delayed for from twelve to twenty-four hours. But the importance of the part played by the toxic properties of the fluid in causing death has not been made clear. Experiments were undertaken to investigate the relative importance of the toxic bodies present in the peritoneal fluid formed in cats with small, non-viable loops of strangulated intestine.

METHODS OF EXPERIMENT

Effects of Residual Peritoneal Fluid.—Some preliminary experiments were made upon the peritoneal transudate collected from cats dying from black loops 15 to 25 cm. in length, constructed by the method of Knight and Slome. The histamine content of the transudate was determined in 5 cats by the unmodified Barsoum-Gaddum (1935) method. The values obtained are shown below:—

Cat No.	*Histamine Content per c.c. (Base)*	*Total Volume of Peritoneal Fluid*	*Total Amount of Histamine Present*
16	0·075γ	26	1·95γ
17	0·016γ	55	0·88γ
19	0·015γ	20	0·3γ
20	0·03γ	18	0·54γ
22	0·0226γ	25	0·565γ

These values are so small that any effect of such amounts upon the blood-pressure of the cat would not be of practical significance.

The peritoneal transudate was also treated with alcohol of various percentages, and the soluble and insoluble fractions were tested upon the blood-pressure of the normal cat. This procedure was adopted in the hope of finding a toxic proteose, but the results were inconclusive—none of the fractions had more than a transitory depressor effect upon the blood-pressure.

The untreated peritoneal fluid was injected intravenously into normal cats on many occasions during this part of the work, and it was found that the acute depressor reaction was almost always obtained; but the stabilization of blood-pressure at a lower level was not observed. The blood-pressure remained at a

level lower than the normal resting level for a short time after the injections, but if the record was continued for several hours the blood-pressure returned to its normal value.

At this stage of the investigation Sir Henry Dale suggested to me that if one looked for the toxic substance or substances only in the residual peritoneal fluid, one was dealing with what remained after an unknown amount had been absorbed before death, and that one's chance of obtaining the responsible factor or factors, if they existed at all, would thereby be greatly diminished. The following experiments were designed to overcome this objection.

Methods of Obtaining Fluid similar to the Peritoneal Fluid present with Non-viable Strangulated Loops.—

1. *Incubation of Excised Intestinal Loops.*—In the strangulated loop the circulation soon becomes practically arrested, at least in a large part of the tissue. It was thought that by incubating excised loops of normal intestine in saline, toxic bodies similar to those present in the transudate formed by loops of strangulated intestine might be formed. Accordingly normal small intestines of cats were incubated in physiological saline at 37° C. for twenty-four hours. This method was soon abandoned, because it was felt that the conditions did not simulate closely enough those obtaining in the animal with a strangulated intestine. The completely excised gut is deprived of all its vascular and nervous connections, and extensive putrefactive changes rapidly appear, while *in vivo* the arterial supply, nerve-supply, and lymph drainage are intact, and putrefaction, while it may occur in the late stages, is never far advanced.

2. *Artificial Perfusion of the Excised Intestine.*—The isolated small intestine of the cat was perfused with defibrinated blood from a Dale-Schuster pump and strangulated *in vitro*. For the preliminary dissection and preparation of the gut for perfusion the cat was anæsthetized with chloralose. The gut was severed at the ileo-cæcal and duodeno-jejunal junctions and the ends were turned in. To make room in the abdominal cavity for dissection, the large intestine, stomach, duodenum, and spleen were removed. The small intestine was dissected free save for the superior mesenteric artery and vein, and the aorta was freed from the diaphragm to just above its bifurcation, and all its branches, except the superior mesenteric artery, were ligatured and cut. With the intestine prepared in this way, a cannula connected with the pump could be inserted into the abdominal aorta, below the origin of the superior mesenteric artery, without interruption of the intestinal blood-supply. As the pump was started the aorta proximal to the superior mesenteric artery was tied. Thus it was possible to prevent even a momentary ischæmia of the intestine, and the consequent changes in the intestinal wall which would unnecessarily complicate the experiment. Immediately after the establishment of the artificial circulation, the superior mesenteric vein was either cannulated or tied. In the earlier experiments a cannula was inserted and the blood was allowed to circulate normally for one-half to one hour, before strangulation was produced by the occlusion of the vein. There seemed to be no rational basis for this procedure, and in later experiments the vein was tied immediately after the establishment of the artificial circulation. The aorta and superior mesenteric vein were then cut beyond the ligatures and the intestine lifted from the body of the cat and placed in a warm moist chamber at 37° C. on a gauze sling; all the transudate dripped into a receiving vessel, which was surrounded by ice. In the

later experiments, instead of perfusing from the pump, the blood was supplied by a donor cat, whose carotid artery was connected by paraffined tubes to the aortic cannula. The donor cat usually survived for from 1 to 2½ hours, and the perfusion was then continued by delivering the blood from a reservoir under a constant pressure (usually 40 to 60 mm. Hg) into the aorta. In one experiment the intestines were placed in an atmosphere of nitrogen to provide partly anaerobic conditions.

3. *Isolation of Strangulated Loops from the Peritoneal Cavity.*—To collect peritoneal fluid from surviving cats and prevent absorption as much as possible, non-viable black loops, constructed by the method of Knight and Slome, were enclosed in bags of thin rubber. With full aseptic precautions, in a cat anæsthetized with ether, the abdomen was opened and a piece of small intestine, 15 to 20 cm. long, in the ileal region was selected. The lumen above and below was occluded by passing ligatures round the bowel, and the veins draining the intestine between the ligatures were dissected free and tied. Collateral venous drainage through the vascular arcade in the mesentery at its attachment to the intestine was also carefully tied off. The strangulated loop was then enclosed in a thin rubber bag; leakage was prevented by suturing omentum around the neck of the bag and the entering and returning loops of gut. The bag and its contents were returned to the peritoneal cavity and the abdominal wall closed.

The success of this procedure was judged later by the presence or absence of free fluid in the peritoneal cavity, and by the condition of the thoracic duct. If the blood-stained transudate from a strangulated segment is free in the abdominal cavity, the thoracic duct shows a reddish-brown colour due to the presence of the absorbed transudate. The animals were killed after from 24 to 26 hours and the fluid in the bag was collected. This survival period was chosen because, if a strangulated loop of this length is left free in the peritoneal cavity, the average survival time is from 20 to 24 hours.

4. The histamine content of some samples of fluid obtained by the various methods was determined by Code's (1937) modification of the Barsoum-Gaddum method. Choline was estimated as acetylcholine by the method described by Brown and Feldberg (1936).

5. All cats used for determining the effect of injected fluids on the blood-pressure were anæsthetized with chloralose (70 mg. per kilo body-weight). Both vagi were cut in the neck. The blood-pressure was recorded from the carotid artery, and all injections and slow infusions were given into the right femoral vein.

RESULTS OF EXPERIMENTS

1. Isolated Perfused Intestine.—During the first 10 to 12 hours the condition of the isolated, perfused, strangulated intestine closely resembled that of the non-viable 'black loop'; at 24 hours putrefactive changes were more prominent than in a typical 'black loop' contained in the abdominal cavity. Peristalsis was observed as late as 8 or 9 hours after the onset of strangulation. Histological sections of the intestine, strangulated *in vitro*, closely resembled those of the strangulated intestine retained in the abdominal cavity.

In two experiments in which a donor cat was used to supply the blood to the whole strangulated small intestine, the donors remained in fair condition for 2½ hours and 2 hours 10 minutes respectively; in the former the blood-pressure

remained constant at 130 mm. Hg, and in the latter the blood-pressure fell from 160 mm. Hg to 80 mm. Hg during these periods. Their blood-pressures then declined gradually in spite of intravenous injections of saline and blood transfusions. In the three other experiments intravenous injections of saline and blood transfusions were given after forty to sixty minutes in order to keep the donors alive. An animal with the whole small intestine strangulated dies as a rule within from one to two hours. It may be noted, therefore, that the relatively short survival period of the last four donor cats is not without significance for the interpretation of the shock produced by 'long loop' strangulation. These cats were anæsthetized with a dose of chloralose, which, by itself and without loss of blood, would allow them to survive for many hours, if not eventually to recover. Their only connection with the strangulated bowel was by the carotid artery, and no toxic products of strangulation could pass into their circulation. Knight and Slome state that in their cross-circulation experiments the donor animal remained in good condition, while the cat with the strangulated intestine died, although it was not suffering from any fluid loss. The first experiment reported above supports this statement, but the last four show that loss of circulating blood volume may play, in some cases, an important part in causing death in 'long loop' strangulation.

The amount of transudate collected varied according to the pressure at which the perfusion was carried out. It was dark red, and its smell became increasingly foul as the perfusion progressed, and towards the end of the experiment it had a sour, sickly odour. Grossly it resembled the fluid collected from the peritoneal cavity of cats with non-viable loops. It contained a moderate quantity of red blood-cells.

The fluid was centrifuged and the supernatant portion was injected intravenously into normal cats in amounts of 5–10 c.c. The effect observed depended upon whether the fluid injected was obtained early or late in the perfusion. Up to the eleventh or twelfth hours, the transudate had only a negligible evanescent depressor action, even when given in amounts of 20 c.c. If collected from the eighteenth hour onward, doses of 5 c.c., given intravenously, caused a sharp fall of blood-pressure, usually followed by a rapid rise above normal and a slow decline to the resting level. During the fall, cardiac irregularities were sometimes observed, but since these may also be seen in the vagotomized cat with an initially high blood-pressure after small doses of histamine and acetycholine, it is not justifiable to attribute them to some specific substance or substances in the intestinal transudate which have a direct action on the heart.

Atropine decreased slightly the depressor effect of the fluid and unmasked the following pressor effect (*Fig.* 496). This suggested the presence of choline. The fluid obtained from two experiments in which the perfusion was maintained for over twenty hours, produced a combined depressor-pressor action, as already described, but after a total of 25 to 35 c.c. had been injected the cat died suddenly from pulmonary œdema.

Slow intravenous infusion of the fluid into the right femoral vein had no immediate effect upon the level of the blood-pressure, but after a varying time the blood-pressure suddenly dropped to zero. In one cat, which received 28 c.c. of transudate, there was marked pulmonary œdema; in the other, which received 48 c.c. of transudate, death was apparently due to failure of the right side of the heart.

The histamine content and choline content of the transudate from the anaerobic perfusion collected during from 18 to 24 hours of perfusion was determined by the methods already described. There was 0·3 to 0·4 γ histamine (base) and 40 to 45 γ choline per c.c. of transudate. It was found that an artificial mixture of histamine and choline in these proportions closely duplicated the depressor action of the fluid (*Fig.* 497), but that a slow infusion of the mixture, in a quantity equal to that of the transudate which proved fatal, had no effect upon the blood-pressure of the cat.

This result suggested that the transudate from the isolated, perfused, strangulated intestine had two distinct actions upon the animal into which it was injected :—

1. If given rapidly by vein in small doses, it produced a combined depressor-pressor reaction which quickly passed away, leaving the blood-pressure at a normal level, the depressor reaction being adequately explained by the histamine and choline content of the fluid.

2. If given intravenously it had a cumulative fatal effect. This was seen after several rapid injections, the combined volume of which was 25 c.c. or more.

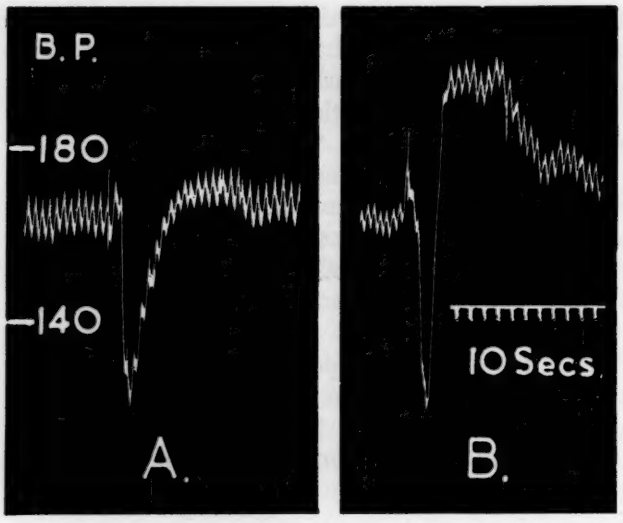

FIG. 496.—Intravenous injections of 5 c.c. of transudate from aerobic perfusion of isolated intestine. A, before atropine; B, after 2 mg. atropine.

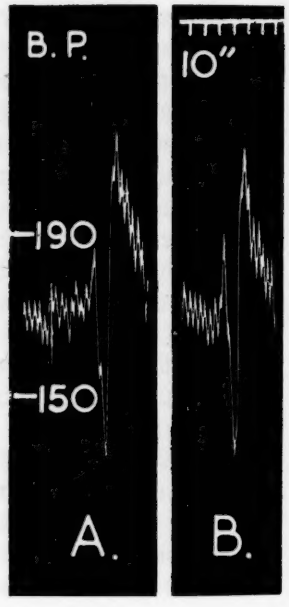

FIG. 497.—A, Injection of 0·5 c.c. transudate collected during twenty-fourth hour of anaerobic perfusion of isolated intestine; B, Injection of 0·5 c.c. of physiological saline containing 0·4 γ histamine base per c.c. and 45 γ choline per c.c.

While it is realized that the effects obtained with the transudate from the isolated intestine are not wholly similar to those seen in animals with strangulated intestines, the results suggested that the blood-pressure reaction used by Knight and Slome (an immediate and brief depressor reaction, followed in some cases by a stabilization of blood-pressure at a permanently lower level) for measuring the toxicity of the peritoneal fluid, mesenteric venous blood, and thoracic-duct lymph from cats with non-viable loops, was chiefly, if not entirely, a manifestation of histamine, choline, and other depressor substances which one would expect to be formed in a segment of strangulated intestine; and that any permanent and prolonged depressant action of the peritoneal transudate on the circulatory system

would be more accurately estimated if the fluid were given slowly and continuously, since in the animal with strangulation it is absorbed into the circulation in this way.

To test this hypothesis a series of non-viable loops were made as described above.

2. Effects of Fluid from Loops Strangulated in vivo.—The fluid obtained from the bag enclosing the loop was used in the following ways :—

a. The amounts of histamine which caused falls of blood-pressure equivalent to those caused by 1 c.c. of the raw uncentrifuged transudate before and after atropine were determined. These values will be called the histamine equivalents. The amounts of histamine and choline present were estimated by the methods of Code and Brown and Feldberg.

b. The transudate was infused slowly by vein into normal animals and into animals which had had their circulating blood volume depleted by the withdrawal of blood.

c. The transudate was injected with aseptic precautions into the peritoneal cavity of normal cats and of cats whose circulating blood volume had been depleted by the withdrawal of blood.

a. Histamine and Choline Content of the Transudate.—Table I shows the histamine equivalents of the raw fluid before and after atropine, the amounts of histamine and choline per cubic centimetre of transudate, and the total quantity of histamine in the transudate. *Figs.* 498–501 show examples of the assay of the histamine and choline contents of the bag fluid from *Cats* 10 and 11.

Table I.—Histamine and Choline Content of the Transudate

Cat No.	Length of Loop	Time	Fluid in Bag	Histamine Equivalent of 1 c.c. Raw Fluid		Histamine (Base) Content per c.c.	Total Histamine (Base) in Transudate	Choline Content per c.c.	
				Before Atropine	After Atropine			Blood-pressure	Rabbit's Gut
	cm.	hr.	c.c.			G.P.			
1	20	24	45	–	0·08γ	1·818γ 2·00γ	90·0γ	75·0γ	74·0γ
2	20	24	100	–	0·054γ	0·330γ 0·290γ	33·0γ	15·0γ	23·2γ
3	20	24	33	0·41γ	0·12γ	1·583γ	52·239γ	8·75γ	8·125γ
4	15	24	30	0·33γ	0·3γ	1·523γ 1·416γ	44·0γ	12·5γ	9·58γ
5	15	24	59	1·0γ	0·9γ	1·208γ 1·375γ	79·0γ	17·5γ	16·875γ
10	20	24	58	–	–	G.P. B.P. 1·32γ 1·33γ 1·38γ 1·33γ	88·3γ	30·5γ	26·5γ
11	20	36	102	–	–	1·83γ 1·5γ — 1·58γ	186·66γ	21·0γ	16·625γ

Note.—G.P. = Assay on guinea-pig ileum.
B.P. = Assay on blood-pressure of atropinized cat.

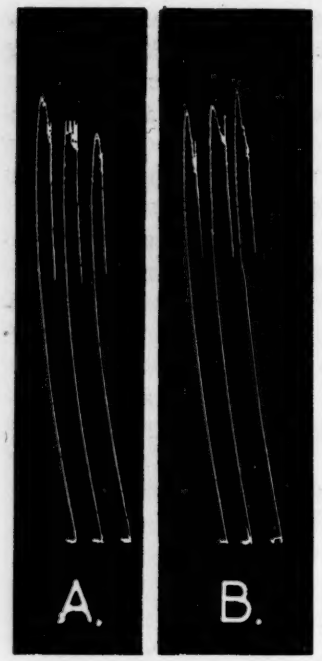

FIG. 498.—Isolated guinea-pig ileum. A, from left to right, 1·0 c.c. 1–5,000,000 histamine phosphate, 0·05 c.c. extract of bag fluid from *Cat* 10, 0·98 c.c. 1–5,000,000 histamine phosphate. B, from left to right, 0·21 c.c. 1–1,000,000 histamine phosphate, 0·05 c.c. extract of bag fluid from *Cat* 10, 0·22 c.c. 1–1,000,000 histamine phosphate.

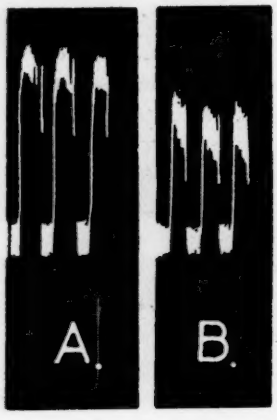

FIG. 500.—Rabbit's jejunum. A, from left to right, 0·11 c.c. 1–200,000 acetylcholine, 0·2 c.c. 1–10 dilution of acetylated extract of bag fluid from *Cat* 10, 0·1 c.c. 1–200,000 acetylcholine. B, from left to right, 0·13 c.c. 1–400,000 acetylcholine, 0·2 c.c. 1–10 dilution of acetylated extract of bag fluid from *Cat* 11, 0·12 c.c. 1–400,000 acetylcholine.

The values for the total histamine content of the transudate ranged from 33 γ to 186 γ (base) and the histamine content of 1 c.c. of transudate varied from 0·33 γ to 2·0 γ (base). The total choline values for the peritoneal fluid were between 8·0 γ and 75·0 γ.

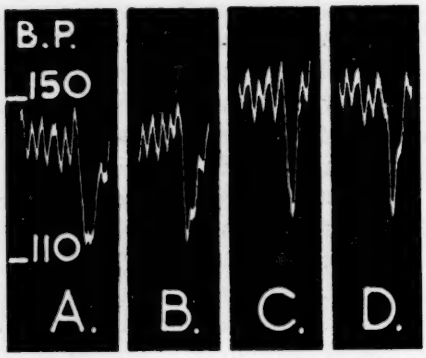

FIG. 499.—Blood-pressure of atropinized cat. A, 0·1 c.c. histamine extract of bag fluid from *Cat* 10. B, 0·4 γ histamine phosphate. C, 0·1 c.c. histamine extract of bag fluid from *Cat* 11. D, 0·45 γ histamine phosphate.

An injection into a normal cat of 1 c.c. of transudate caused a sharp depression of blood-pressure, followed by a rise above the normal and a gradual return to the resting level. Sometimes irregularities of the heart beat were observed during this last phase. After atropine the depressor response was diminished

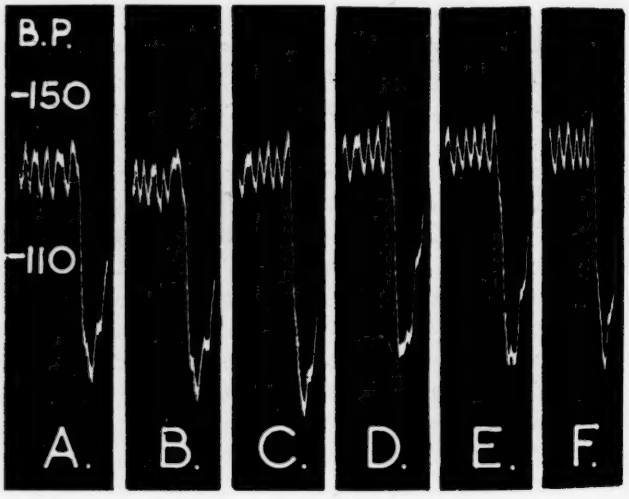

FIG. 501.—Blood-pressure of cat. A, 0·3 γ acetylcholine. B, 0·1 c.c. 1–10 dilution of acetylated extract of bag fluid from *Cat* 10. C, 0·31 γ acetylcholine. D, 0·2 γ acetylcholine. E, 0·1 c.c. 1–10 dilution of acetylated extract of bag fluid from *Cat* 11. F, 0·22 γ acetylcholine.

and the pressor reaction slightly increased. From a comparison of the histamine equivalents with the estimated amounts of histamine and choline per cubic centimetre of fluid, it is evident that the process of extraction has either destroyed pressor substances, which partly masked the depressor activity, or liberated histamine and choline, which were present in the raw fluid in some inactive form. In any case the amounts of histamine and choline present in the fluid will adequately account for the acute depressor reaction of the transudate. But at the same time the quantities of these substances are insufficient in themselves to have any permanent, deleterious effect upon the normal animal.

Aird and Henderson (1937) found that the total histamine in the peritoneal fluid, collected in rubber bags surrounding non-viable strangulated loops of small intestine of the cat after twenty-four hours, varied from 0·5 to 4·0 mg. (base). The methods of constructing the loop used by Aird and Henderson differed from my method in that they restored the continuity of the bowel; but it is unlikely that the wide disparity between the two series of histamine values can be explained by the different operative procedures. Wahren (1936), using the fluid collected in bags surrounding 30 cm. of strangulated segment of the ileum in rabbits, could find only traces of histamine. He also found only insignificant amounts of acetylcholine, adenylic acid, and von Euler and Gaddum's "P" substance.

No references to choline estimations in the peritoneal transudate of intestinal strangulation have been found. Nesbitt (1899), however, found increased quantities of choline and neurine in the contents of the obstructed intestine, and suggested that they might be of importance in causing the symptoms seen in this condition. Sweet, Peet, and Hendrix (1916) found a choline-like substance in the intestinal contents above an obstruction of the duodenum in the dog, in which the pancreatic ducts had been tied; they do not mention the methods of analysis or the amounts of the substances found.

Knight and Slome stated, in discussing the depressor action of the peritoneal transudate, mesenteric venous blood, and thoracic-duct lymph collected from animals with strangulations, that "it may be inferred that its (the depressor substance) slow continuous absorption from any site will produce a similar effect. That repeated or large doses do produce a permanent depression of blood-pressure comparable with the clinical picture of strangulation is characteristic of all our reactions." The level of the blood-pressure from the time of strangulation to the death of the animal was not, however, recorded by them. I have, accordingly, made experiments to investigate the blood-pressure changes during this period, and at the same time the sensitiveness to histamine of the animal with an intestinal strangulation; for it was thought possible that such an animal might be more sensitive to histamine than the normal, so that the small quantities of this compound found in the peritoneal fluid might have a more serious effect upon its circulation than upon that of the intact animal.

The experiments were performed in this way: An animal was anæsthetized with chloralose, and the response to 0·5 γ histamine base (in some experiments 0·2 γ base was used), as shown by depression of the blood-pressure, was first measured. A 'black loop', 20 cm. long, was then constructed in the usual way, and the abdomen was closed. The blood-pressure was recorded from the carotid artery for twelve hours, and at intervals of an hour 0·5 γ histamine base was injected intravenously. For the later period, the continuous anæsthesia with

chloralose, from the time of strangulation of the intestinal loop, would probably have complicated the effects produced by the strangulation alone. The following procedure was therefore adopted. At 10 p.m. the animal was anæsthetized with ether and prepared for operation under aseptic conditions. The right femoral artery was exposed by an incision in the groin, and the blood-pressure was measured by arterial puncture. Then 0·5 γ histamine base was injected into the right femoral vein and its effect on the blood-pressure noted. The incision in the groin was closed. The abdomen was opened and a 'black loop', 20 cm. long, was constructed. After closure of the wound the animal was placed in the recovery room. The following day the animal was anæsthetized with chloralose and the blood-pressure recorded from the carotid artery, and at hourly intervals 0·5 γ histamine base was injected intravenously. No increased effect upon the blood-pressure was found. The response to repeated doses of histamine remained essentially the same throughout each experiment; in some cases the response gradually grew less. In any case there was evidence against any increase of sensitiveness to histamine as a factor in the ultimate effects of strangulation.

In these experiments it was found that the blood-pressure remained at a high level during the first 12–18 hours of the experiment. In three cats the blood-pressure readings 12 hours after the production of strangulation were 170 mm. Hg, 150 mm. Hg, and 140 mm. Hg. In the first of these the blood-pressure had fallen to 100 to 110 mm. Hg 17 hours after strangulation; following this it dropped to 60 mm. Hg, but gradually recovered to 100 mm. Hg just before death, 21¾ hours after the construction of the 'black loop'. In the second cat the blood-pressure remained at above 100 mm. Hg until the hour preceding death, when there was a steady decline to 60 to 70 mm. Hg, and a sudden final drop as death occurred. During the last phase in this experiment the blood-pressure showed large swings which were not connected with respiration. No satisfactory explanation was found.

b. Slow Intravenous Infusion of Peritoneal Transudate and of Mixtures of Histamine and Choline.—The peritoneal transudate, collected from the rubber bag surrounding the strangulated loop of intestine, was slowly infused into the right femoral vein of cats anæsthetized with chloralose. In some experiments, blood was withdrawn from the vein during the infusion to represent the loss of total fluid from the circulation suffered by the cat from which the transudate was obtained. This total fluid loss was calculated by measuring the amount of fluid in the bag and adding to this the increase in weight of the strangulated loop. The increase in weight was determined by subtracting from the weight of the loop the average of the weights of two 20-cm. lengths of normal small intestine above, and of one 20-cm. length below, the strangulation. The figures obtained were expressed as percentages of the body-weight, and, with the exception of three high values, 2·9 per cent, 3·18 per cent, and 3·2 per cent, ranged from 1·45 per cent to 2·5 per cent, or from 19 per cent to 33 per cent of the blood volume (calculated as 7·5 per cent of the body-weight). Such a blood loss is in itself insufficient to cause death in the normal animal, as Blalock (1927) has shown. These figures agree well with those of Aird (1935), but are slightly greater than those of Knight and Slome, whose experiments were performed without enclosing the loop in a rubber bag.

Seven slow infusion experiments without the withdrawal of blood were performed, and four of the test animals survived. The blood-pressure in two of these

was higher at the end of the experiment than at the beginning, while in two the blood-pressure fell, but never below 120 mm. Hg, and gradually rose when the infusion was stopped (*Fig.* 502). Cats anæsthetized with chloralose, and otherwise untreated, frequently show similar falls from a high initial pressure under normal conditions. In three experiments death occurred, although no blood was withdrawn. In only one did the death resemble in any way the circulatory

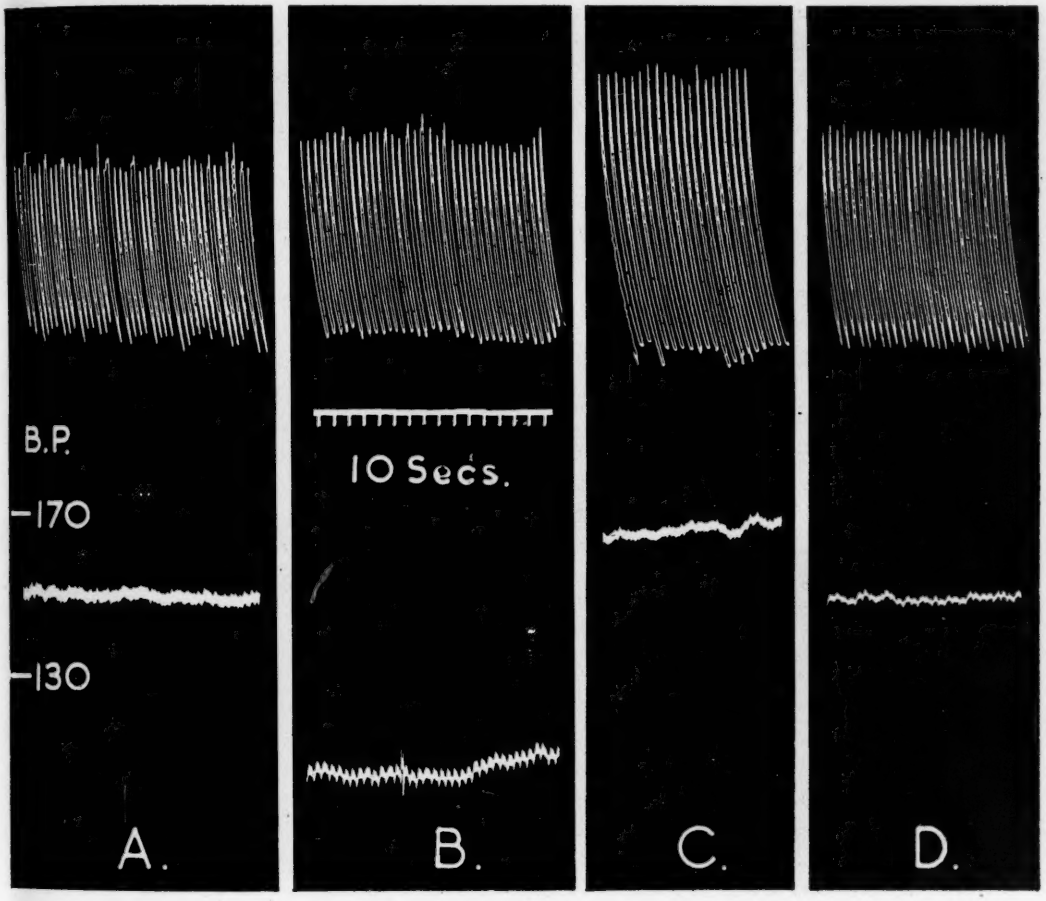

FIG. 502.—Blood-pressure and respirations of cat, to which 55 c.c. bag fluid from *Cat* 2 were given slowly intravenously. A, Blood-pressure, 12 noon. B, 12·20 p.m., slow infusion started. C, 5.20 p.m., slow infusion off. D, Blood-pressure at 7·0 p.m.

collapse seen in animals with strangulation of the intestine. Fifty-one c.c. of peritoneal transudate were infused in 2 hr. 44 min., the blood-pressure dropping from 180 mm. to 110 mm. Hg; after stopping the slow infusion, the blood-pressure continued to fall, and the animal died about one hour later. In one of the other experiments, death suddenly occurred after only 18 c.c. of fluid had been infused. This fluid was collected about twelve hours post mortem and the validity of the result is therefore questionable. It is noteworthy, however, that its histamine and choline contents were of the same order as those found in uncomplicated experiments. In the other fatal experiment, respiration failed,

while the blood-pressure was still high, after 15·8 c.c. had been given out of a total of 40 c.c. of transudate. Artificial respiration kept the animal alive for two hours, during which the blood-pressure gradually declined to zero.

The fluid obtained in *Exp.* 12 was infused into a cat, and blood was withdrawn up to 2·1 per cent of its body-weight, to represent loss of fluid from the circulation

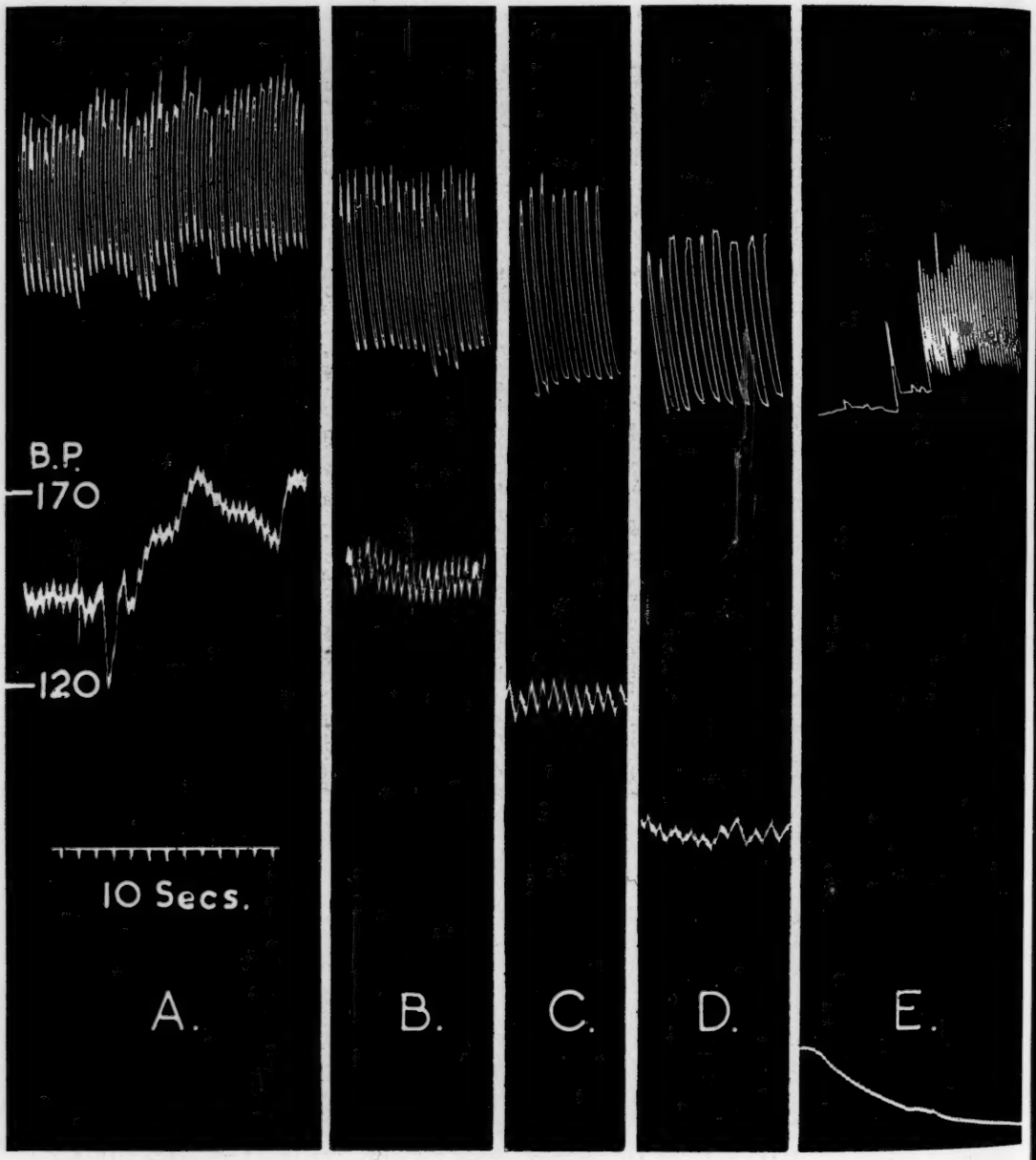

FIG. 503.—Blood-pressure tracing and respiration of cat which received 15·4 c.c. per kilo bag fluid from *Cat* 12, and from which blood up to 2·1 per cent of body-weight was withdrawn. A, 2.55 p.m., 3 c.c. bag fluid. B, 3.12 p.m., slow infusion started. C, 4.00 p.m. D, 5.40 p.m. E, 5·50 p.m., died. Artificial respiration of no avail.

of the animal from which the transudate was collected. Death occurred in 3½ hours after 15·4 c.c. per kilo of body-weight had been infused (*Fig.* 503). The remainder of the fluid, of which there was sufficient for a dose of 13·5 c.c. per kilo, was infused into another cat, from which no blood was removed. This cat survived, the blood-pressure falling from 160 mm. to 124 mm. Hg at the end of the infusion (1 hr. 47 min.), and rising again, until at the end of the experiment (1 hr. 54 min. later) it was 140 mm. Hg (*Fig.* 504).

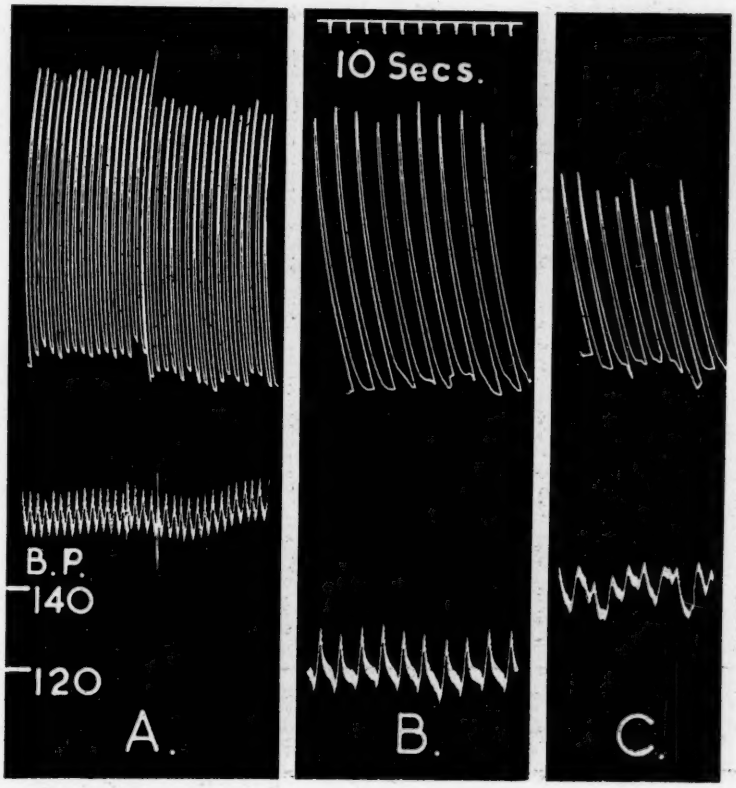

FIG. 504.—Blood-pressure tracing and respiration of cat, which received 13·5 c.c. per kilo bag fluid from *Cat* 12. No blood withdrawn. A, 3.20 p.m., slow infusion started. B, 5.10 p.m., slow infusion off. C, 7.0 p.m.

Combination of slow infusion and withdrawal of blood always caused death. But here again the manner of death was not always comparable to that seen in strangulation of the intestine, for in one experiment respiration ceased after only 18 c.c. of fluid had been infused. Artificial respiration was then applied and the cat died after 2 hours 50 minutes, by which time a total of 70 c.c. of transudate had been given. The results of these experiments are given in *Table II.*

These results show that while the slow intravenous infusion of transudate may prove fatal, it does not invariably cause death, and that its lethal effect, when present, is not always comparable to the cardiovascular failure seen in strangulation shock, for the respiratory centre may fail before the blood-pressure is significantly lowered: artificial respiration will then prolong life. Since histamine and choline

Table II.—Results of Intravenous

Source of Fluid								
Exp. No.	Weight of cat	Length of loop	Amount of fluid	Survival time	Fluid loss	Weight of cat	Total amount of fluid	Fluid in c.c. per kilo
	kg.	cm.	c.c.	hr.	per cent	kg.	c.c.	c.c.
1	–	20	45	24	–	4·3	34·5	8·0
2	–	20	75	24	–	3·2	55·0	17·1
9	2·5	20	35	24	–	2·7	35·0	12·9
12	5·0	20	92	24	2·1775	2·7	36·5	13·5
12	5·0	20	92	24	2·1775	3·3	47·8	15·4
10	4·45	20	58	24	1·45	4·1	34·3	8·36
13	4·5	20	70	24	2·06	3·8	70·0	18·4
11	5·35	20	102	36	2·04	2·6	18·0	6·9
14	4·0	20	51	24	1·69	3·2	51·0	15·9
16	3·6	20	40	24	1·66	2·7	40·0	14·8

Table III.—Intravenous Infusion of Mixture of Histamine and Choline in the Proportions Found in Transudate from Cat 10.
(1·3 γ histamine base, 30 γ choline per c.c.)

Date	Weight of Cat	Total Dose	Dose in c.c. per kilo	Rate of Infusion	Fluid Loss	Time	Result
	kg.	c.c.	c.c.	c.c./min.	per cent		
July 2, 1937	2·8	22·5 (23·4)	8 (8·36)	1/3·8 (1/2·8)	0·92 (1·17)	1 hr. 26 min. (1 hr. 39 min.)	Died
July 9, 1937	4·3	100 (36·94)	23·2 (8·36)	1/3·64 (1/2·8)	1·6 (1·17)	6 hr. 14 min. (1 hr. 37 min.)	Survived; blood-pressure fell from 206 mm. to 98 mm. Hg
July 12, 1937	3·1	96·6 (25·8)	31·1 (8·36)	1/2·8 (1/2·8)	1·75 (1·17)	5 hr. 53 min. (1 hr. 37 min.)	Died

INFUSION OF PERITONEAL TRANSUDATE

SLOW INFUSIONS

RATE OF INFUSION	TIME OF INFUSION	BLOOD-PRESSURE			TOTAL TIME OF EXPERIMENT	FLUID LOSS AS PERCENTAGE BODY-WEIGHT	RESULT	REMARKS
		Initial	At End of Infusion	At End of Exp.				
c.c./min.								
1/3·7	2 hr. 10 min.	166	166	170	2 hr. 40 min.	–	Lived	
1/5·4	5 hr.	120	160	160	6 hr. 25 min.	–	Lived	
1/3·3	1 hr. 56 min.	166	140	160	3 hr. 43 min.	–	Lived	
1/2·9	1 hr. 47 min.	160	124	140	3 hr. 31 min.	–	Lived	
1/4·5	3 hr. 38 min.	146	0	0	3 hr. 38 min.	2·1	Died	Artificial respiration of no avail
1/2·8	1 hr. 33 min.	150	0	0	1 hr. 33 min.	1·17	Died	
1/3·2	3 hr. 5 min.	166	86	0	4 hr.	2·0	Died	Respirations failed after 18 c.c. fluid were given. Artificial respiration given
1/3·9	1 hr. 10 min.	136	0	0	1 hr. 10 min.	–	Died	Fluid collected 12 hrs. post mortem
1/5·1	2 hr. 44 min.	180	110	0	3 hr. 51 min.	–	Died	Artificial respiration of no avail
1/3·55	2 hr. 22 min.	170	76	0	3 hr. 27 min.	–	Died	Respirations failed after 15·8 c.c. had been infused. Artificial respiration given

Table IV.—INTRAVENOUS INFUSION OF MIXTURE OF HISTAMINE AND CHOLINE IN THE PROPORTIONS FOUND IN TRANSUDATE FROM CAT 11
(1·63 γ histamine base, 18·6 γ choline per c.c.)

DATE	WEIGHT OF CAT	TOTAL DOSE	DOSE IN C.C. PER KILO	RATE OF INFUSION	FLUID LOSS	TIME	RESULT
	kg.	c.c.	c.c.	c.c./min.	per cent		
July 19, 1937	2·5	32·8	13·1	1/3·8	1·14 (2·06)	2 hr. 6 min.	Died
July 19, 1937	2·6	75·0	28·8	1/3·0	2·06 (2·06)	4 hr. 22 min.	During time of blood loss blood-pressure dropped to as low as 45 mm. Hg. After stopping withdrawal of blood blood - pressure rose and stabilized at 65–70 mm. Hg. Respiration slowed from 14 per min. to 7 per min.

in the proportions found in the peritoneal fluid are not lethal by themselves, one may conclude that in those specimens which were killed an additional toxic substance or substances were present, but that such toxic bodies are not always present in effective amounts, as is shown by those experiments in which no lethal effect was demonstrated.

Mixtures of histamine and choline in the proportions found in the peritoneal transudates from *Exp.* 10 and 11 were made in physiological saline, and infused by vein, while blood was withdrawn to represent the diminution in blood volume

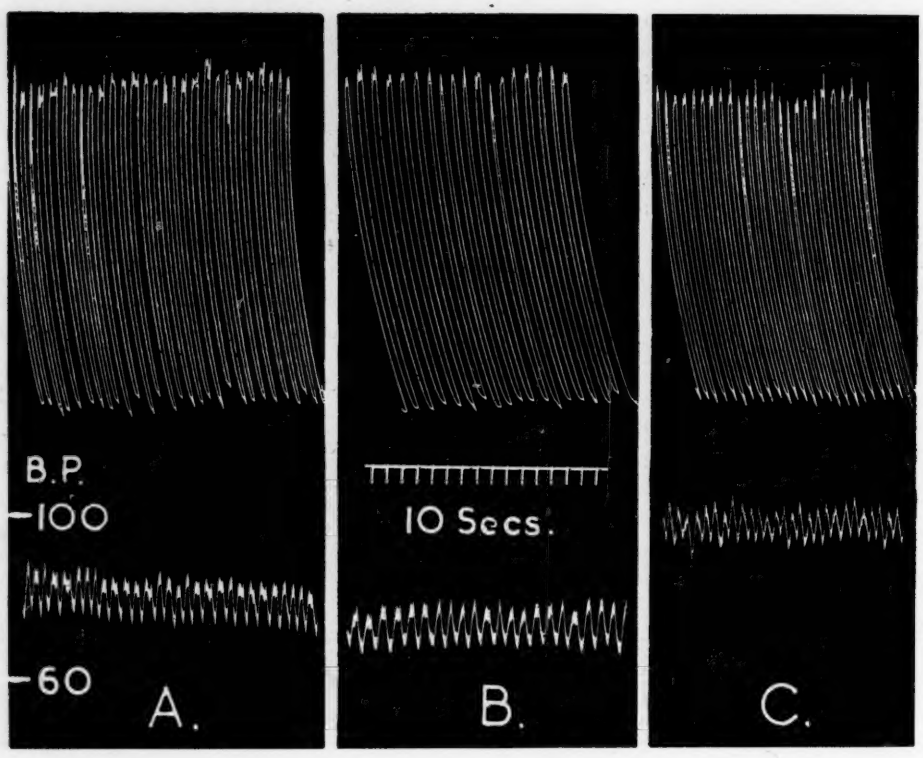

FIG. 505.—Blood-pressure and respiration of a cat which received slow infusion of 50 c.c. of a mixture of histamine phosphate 1·2γ per c.c. and choline 45γ per c.c. A, 11.50 a.m., slow infusion started. B, 1.50 p.m. C, 5.0 p.m., blood-pressure and respiration ten minutes after stopping slow infusion.

suffered by the animal from which the transudate was obtained. The results are shown in *Tables III, IV*. (The dose of the raw transudate—*Exp.* 10—in cubic centimetres per kilo of body-weight which killed an animal from which blood had been withdrawn, the time taken by this dose to kill, the rate of infusion, and the fluid loss suffered by this animal are shown in parenthesis.) In one experiment, in which the artificial mixture containing histamine and choline in the proportions found in the transudate from *Exp.* 10 was infused, the animal died in the calculated time, after the calculated dose had been given, and the calculated quantity of blood withdrawn. But this result could not be obtained again. In another fatal experiment nearly four times the amounts of histamine and choline present in the transudate were given, and the artificially produced fluid loss was one and a half times greater, yet the animal survived for nearly 6 hours; while another animal,

which received three times the calculated amounts of histamine and choline, and whose fluid loss was one and a half times greater than the calculated loss, was still alive 6¼ hours after the beginning of the experiment.

The mixture containing histamine and choline in the proportions found in the transudate of *Exp.* 11 also produced equivocal results. Of two cats, each weighing 2·5 kg., one died in 2 hr. 6 mins. after receiving 13·1 c.c. of the mixture per kilo, and having 1·14 per cent of its blood volume withdrawn, while the other had a blood-pressure of 70 mm. Hg (initial pressure 120 mm. Hg) after 4½ hours, during which 28·8 c.c. of the mixture per kilo had been infused and 2·06 per cent of its blood volume had been withdrawn.

An artificial mixture of histamine and choline in the proportions found in the peritoneal transudate is not fatal, and when slowly infused causes little, if any, depression of blood-pressure, and has no permanent depressor action in the normal cat (*Fig.* 505).

From these experiments one may infer that the histamine and choline in the transudate play only a subsidiary role in the depression of blood-pressure in intestinal strangulation. And since they are present in sufficient quantities to account for the acute fall of blood-pressure seen on intravenous injection of the fluid, one may conclude that the acute depression is not a satisfactory measure of the toxicity of the fluid.

c. Intraperitoneal Injection of Peritoneal Transudate.—The fluid was collected aseptically from the rubber bags surrounding the strangulated loop, and, after measurement of the volume, was immediately injected into the peritoneal cavity of a normal cat of approximately the same or smaller weight. The results are shown in *Table V* below :—

Table V.—Results of Intraperitoneal Injection of Peritoneal Transudate

Cat. No.	Length of Loop	Amount of Fluid	Time	Cat Injected	Results
3*a*	20 cm.	67 c.c.	24 hr.	3*b* May 20, 1937	Killed after one week: well, apart from slight loss of weight and diarrhœa (the latter was present in the whole cat colony)
6 (2·5 kg.)	20 cm.	18 c.c.	24 hr.	6*a* (2·7 kg.) June 1, 1937	June 3, listless, unwell; June 4, well; June 7, well; June 8, well; June 10, well; June 11, well. Killed July 15
7 (2·3 kg.)	20 cm.	56 c.c.	24 hr.	7*a* (2·5 kg.) June 1, 1937	June 3, listless; June 4, well; June 7, loss of weight, but comparatively well; June 8, better than previous day; June 9, well; June 10, well; June 11, well. Killed, June 28
8 (3 kg.)	25 cm.	45 c.c.	24 hr.	8*a* (2·3 kg.) June 8, 1937	June 9, well; June 10, well; June 11, well; July 27, well; Sept. 23, well

Apparently the intraperitoneal injection of the fluid alone has only slight ill effects, from which the animal soon recovers. Post-mortem examination of these

animals revealed no gross pathological lesions. Foster and Hausler (1924) reported that the loop contents and peritoneal fluid collected in bags surrounding long strangulated segments of small intestine of the dog, of 12 hours' duration, produced little effect when given intraperitoneally. Albeck (1902) also found that the intraperitoneal injection of peritoneal transudate derived from cats and rabbits, in which loops of ileum, 20 to 30 cm. long, had been strangulated, was almost without effect. Knight and Slome report a roughly comparable experiment. A black loop, 17 cm. long, was placed in a rubber bag. After 16½ hours the abdomen was opened, and the 45 c.c. of fluid in the bag, together with the loop, were placed inside the peritoneal cavity of another cat. The abdominal walls of the two cats were then sutured together and blood-pressure records were taken from each cat under chloralose anæsthesia. The normal animal died in 3½ hours, after absorbing 30 c.c. of the fluid, and the cat from which the loop was taken died shortly after. This result is, however, difficult to interpret because of the anæsthesia, and the complicated conditions of the experiment.

Similar experiments were performed on ten other animals; in addition, before or after the intraperitoneal injection of fluid, blood was withdrawn from the right jugular vein under ether, to cause a diminution in the circulating blood volume. The cat was then allowed to recover. The amount of transudate injected varied from 51 c.c. to 73 c.c. and the blood removed from 1·08 per cent to 2·00 per cent of the body-weight (average, 1·53 per cent of the body-weight). In this series 3 cats died; one developed peritonitis, and the post-mortem examination of the other two, apart from a small quantity of brownish-red fluid in the peritoneal cavity, revealed no gross abnormalities. The quantities of blood removed were 1·48 per cent, 1·6 per cent, and 1·08 per cent of the body-weight respectively, and the amounts of transudate injected were 56 c.c., 51 c.c., and 56 c.c. The remaining cats were unaffected by the injection of the transudate collected from the rubber bags.

Thus the transudate, injected intraperitoneally and combined with a diminution in the circulating blood volume, is not in the majority of cases sufficiently toxic to cause death in the unanæsthetized animal.

DISCUSSION

The experiments here described were not concerned with the question of nervous effects due to the distension of the strangulated loop of intestine as a possible factor in the fatal results of non-viable strangulation; nor has account been taken of the effects of bacterial activity in the loop. I have been concerned solely with the question of whether the toxic products formed in such a loop, and passing into the fluid transuded from it, are by themselves sufficient to account for the fatal outcome.

The methods of estimating the toxicity of the fluid must be devised so that the experimental conditions resemble as closely as possible those obtaining in the animal with a strangulated intestine. Any toxin or toxins in such an animal are slowly and continuously absorbed from the peritoneal cavity, without the complicating presence of an anæsthetic. The powerful effect of anæsthesia upon the reaction to toxic bodies is well illustrated by the experiments of Dale (1920), in which he showed that the unanæsthetized cat could receive 10 mg. of histamine per kilo of body-weight, intravenously, without ill effect, while the same cat under

ether would pass into a fatal condition of 'histamine shock' if given 2 mg. per kilo of body-weight. For these reasons it seemed possible that the gauging of the toxicity by the rapid intravenous injection of relatively large amounts of transudate into anæsthetized animals, would give a false picture of the toxic properties of the fluid. That this is true is shown by the fact that the small quantities of histamine and choline present in the fluid will account for the acute but evanescent depressor action of the transudate; yet these amounts are quite insufficient to cause any grave circulatory collapse by themselves. It might be argued that the cat with a strangulated intestine is more sensitive to histamine than a normal animal, but no evidence in support of this idea has been found. The experiments in which small quantities of histamine and choline were slowly infused also show that the amounts of these substances are of little importance. The experiments were complicated by chloralose anæsthesia, and it must be emphasized again that, except in one experiment, the quantities infused were greater than those found in the transudate. Thus the deaths, which occurred in this series, lose their significance. With this evidence it may be concluded that histamine plays no part, or only an insignificant part, in causing death in strangulation of the intestine.

The slow infusion experiments are partly invalidated by the short time occupied by the infusion, compared with the relatively long period over which is spread the absorption of transudate from the peritoneal cavity in the animal with a strangulated intestine; and the complicating effects of anæsthesia are more likely to manifest themselves in prolonged experiments. Thus most reliance must be placed upon those experiments in which the transudate was injected intraperitoneally without anæsthesia. The postponement of death by enclosing the loop in a rubber bag shows that the absorption of some toxic factor in the transudate is prevented, but the slow infusion experiments without the withdrawal of blood, and the intraperitoneal injection experiments, show that this toxin is in most cases not sufficiently powerful to kill a normal animal. The deaths which occurred in the slow infusion series, without the withdrawal of blood, suggest, however, that lethal poisons may occasionally be present in amounts great enough to kill a normal, anæsthetized animal; but the lack of resemblance of the manner of death in these test animals to that seen in intestinal strangulation makes it dangerous to assume that the substance responsible for these deaths is the cause of death in strangulation.

The animal with a strangulated intestine, apart from the production and absorption of hypothetical toxins, is suffering a certain degree of diminution of its available total fluids, the degree varying, obviously, with the length of intestine involved in the strangulation. My cross-circulation experiments tend to emphasize the significance of a factor regarded by Holt (1934) as all-important when he stated that, in long loop strangulation, death is "solely due to the withholding of a large volume of blood from the circulation by the loop". I have no evidence to uphold or to disprove his claim that "there is no evidence of any toxæmic process" in such loops. The measured fluid loss in a short (20 cm.) non-viable loop is by itself not great enough to cause death in normal animals.

The slow intravenous infusion of transudate, together with the simultaneous removal of blood in the anæsthetized animal, causes death. But when the fluid is given intraperitoneally, and blood is withdrawn from the jugular vein under ether anæsthesia of 10 to 20 minutes' duration, thus avoiding the effects of prolonged

anæsthesia necessarily present in the slow infusion experiments, death occurs but occasionally.

From the experimental evidence presented in this paper one is forced to the conclusion that the toxic action of the peritoneal transudate formed in non-viable intestinal strangulation, even in conjunction with the concomitant, direct diminution in circulating blood volume, is not, in the majority of cases, sufficient to account for the circulatory collapse seen in this condition.

SUMMARY AND CONCLUSIONS

1. The acute depressor effect of peritoneal transudate, collected in rubber bags surrounding short non-viable loops of small bowel, can adequately be accounted for by the amounts of histamine and choline present. These quantities are not great enough to produce any harmful result by themselves.

2. Histamine plays little or no part in causing death in intestinal strangulation.

3. The animal with a strangulated intestine does not show an increased sensitiveness to histamine.

4. The slow intravenous infusion of peritoneal transudate into normal anæsthetized animals has usually no depressant action upon the blood-pressure. It occasionally kills, but the manner of death does not always resemble that seen in strangulation of the intestines.

5. The slow intravenous infusion of peritoneal transudate into normal anæsthetized animals whose volume of total circulating fluid has been diminished causes death.

6. The intraperitoneal injection of peritoneal transudate into normal unanæsthetized animals has no markedly harmful or permanent effect.

7. The intraperitoneal injection of peritoneal transudate into unanæsthetized animals whose volume of total circulating fluid has been diminished has in most instances no harmful effects.

I wish to express my thanks to Sir Henry Dale for his helpful advice and for providing me with laboratory facilities in the National Institute for Medical Research during the reconstruction of the laboratories of the Royal College of Surgeons.

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SHORT NOTES OF RARE OR OBSCURE CASES

TWO CARCINOMAS OF ONE BREAST

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Cases of double or multiple primary cancers have been the subject of considerable attention in recent years, and, while large series of cases have been reported, little has been noted of double primary cancers of the same organ. For that reason the following example appears to be worthy of record.

History.—The patient, a married woman of 43, with two children, gave a twelve months' history of a swelling in the upper and inner quadrant of the left breast. The lump was slow-growing and painless, and had not involved skin. Three months ago an ulcer had appeared below and internal to the nipple and had grown rapidly, invading the breast deeply.

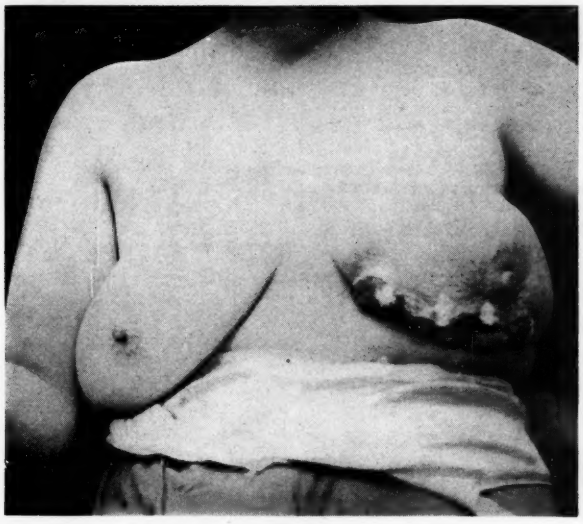

Fig. 506.—Photograph of the breast when first seen.

On Examination.—There was a foul-smelling necrotic ulcer, stretching across the breast below the nipple (*Fig.* 506). The edges were raised and ragged, and there was much surrounding induration. The nipple was somewhat retracted, and the skin was pitted. Palpation revealed a mass stretching up in the breast substance, above the nipple in the main, but apparently continuous below with the indurated area about the ulcer. There was no direct skin invasion above the ulcer, but the upper part of the tumour was extensively adherent to deeper structures. Three large fixed lymph-nodes were palpable in the axilla.

Biopsy showed superficially a keratinizing squamous carcinoma, while in the deeper parts was what appeared to be a cellular carcinoma of the breast.

Operation.—A local amputation of the breast was carried out as a toilet operation preliminary to radiation therapy, but after the operation the patient refused any further treatment and discharged herself.

Pathology.—

Macroscopic.—The specimen consisted of the breast and a small part of the axillary contents. Below the nipple was an excavated ulcer, lying transversely,

measuring 15 × 6 cm. and about 5 cm. deep. The edges of the ulcer were friable and necrotic. A section through the whole breast revealed the following features: The walls of the ulcer were formed by a layer of tumour material about 1·5 cm.

FIG. 507.—Photomicrograph of the wall of the ulcer, showing squamous carcinoma. Hæmatoxylin and eosin. (× 80.)

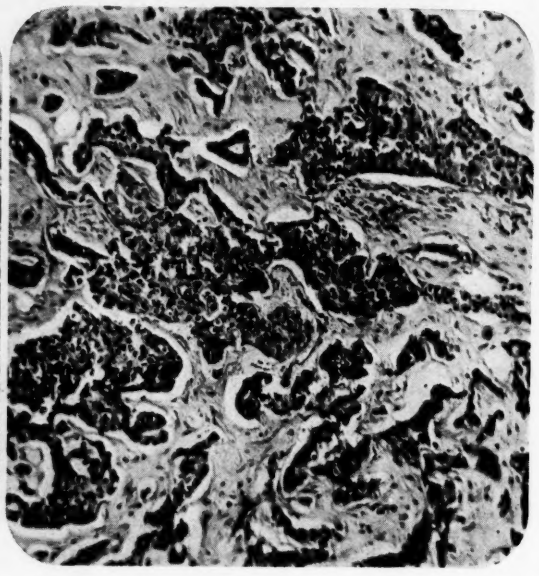

FIG. 508.—Photomicrograph of the upper breast tumour, showing a cellular carcinoma. Hæmatoxylin and eosin. (× 80.)

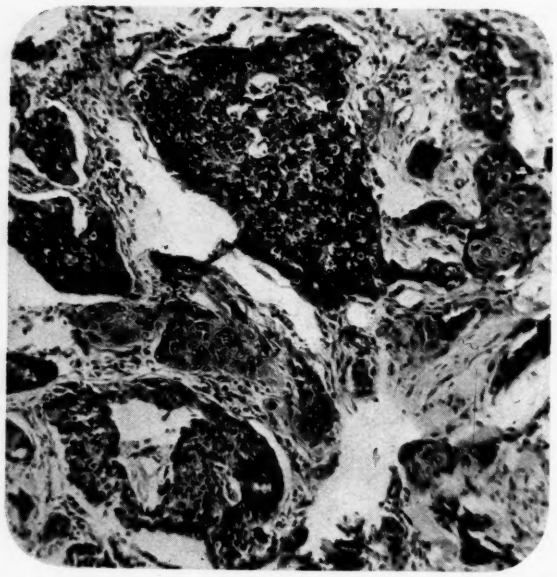

FIG. 509.—Photomicrograph of the area of contact, with the two types of growth lying together. Hæmatoxylin and eosin. (× 90.)

deep in all parts. This tumour was granular in appearance, a dirty grey colour, and rather cheesy. Deep to it was an area of apparently uninvolved fat. Lying

just above and medial to the nipple was a well-defined tumour mass, 5 × 3 × 4 cm. It was firm and elastic in consistence, left a flat, dry surface when cut, and had a slightly violet colour. In the area beneath the nipple it was not as well defined as elsewhere, the firm mass giving way to tumour strands when approaching the ulcer tumour. In an area of 3 × 3 cm. the two tumours were in contact, and the individual features of each were merged into a homogeneous appearance. This layer of contact was about 0·5 cm. thick, and immediately outside it the two types of tumour were clearly recognizable. The upper growth was invading muscle extensively.

A gland found in the axillary fat showed the same features as those of the upper tumour, and had the same violaceous tint.

Microscopic.—Sections from the ulcer wall showed a plexiform type of squamous carcinoma, producing prickle cells, keratin, and cell-nests (*Fig.* 507). Mitoses were frequent. There were areas showing foci of necrosis, and at these points the cells tended to a more transitional form.

Sections from the upper tumour mass showed a very cellular carcinoma of an unusual and rather indeterminate type (*Fig.* 508). The cells lay closely packed, in sharply demarcated clumps and tortuous strands. Continuity of the strands was visible, but each strand had a clear-cut edge, and there was no tendency to diffuse cellular infiltration. The cells contained small deeply staining nuclei and abundant cytoplasm, and the cell boundaries were usually indistinct. Mitotic figures were infrequent, and glandular formation was lacking. No suggestion of intercellular bridges or keratinization was found.

Sections from the area of contact showed the two types of growth lying side by side (*Fig.* 509), each maintaining its own features, and in no part did it appear that one tumour was giving rise to the other. The contrasting cytology of the two growths was emphasized, the cells of the squamous part showing larger, less hæmatoxyphil nuclei and more frequent mitoses, and the cytoplasm being smaller, less acidophil, and more irregular than the cells of the breast carcinoma.

The axillary lymph-node showed the same morphology and cytology as the upper breast tumour, and the node was almost entirely replaced by this type of growth. No evidence of squamous features could be found in the metastasis.

Commentary.—The main point at issue in this case is the possibility that these two apparently different neoplasms were really the result of metaplasia in different parts of one original primary tumour.

The carcinoma presumed to be of breast origin presented some features not usually seen in breast growths, and the fact that ulceration occurred nine months after a lump had been noticed in the breast naturally suggests that the ulceration had supervened on a pre-existing carcinoma. Evidence against a single origin is that the initial ulceration occurred well away from the original tumour, and further, that both the macroscopic and microscopic appearances reveal two separate types of tumour, intermingling at the points of contact, but in no part suggesting a continuity of origin.

Burke, in a recent paper, reviews the literature and adds 46 new cases of multiple primary malignancy. Six were in the same organ, but most of these, as in the cases of many other writers, consisted of the association of carcinoma and sarcoma. Burke, however, described a case comparable to the present one, in which the stomach contained an adenocarcinoma and a squamous carcinoma. The latter, he thought, had

arisen from ectopic œsophageal epithelium. In the present case the squamous growth had presumably arisen from skin epithelium.

Billroth's criteria of double primary malignancy were that each tumour must have a separate histological picture, arise in a different situation, and produce its own metastasis. The present case fulfills the first of these requirements, and from the history the second may be presumed to be satisfied. The question of separate metastasis is not considered of importance, since the presence of metastases is not necessary to diagnose a single malignancy, and there is therefore little reason to require their presence before diagnosing double malignancy.

Warren and Gates, in a comprehensive study of multiple malignancy, came to the conclusion that each tumour must present a definite picture of malignancy, each must be distinct, and the probability of one being a metastasis from the other must be excluded. It is felt that the case under discussion satisfies the demands of the first two of these criteria, and so eliminates the possibility of a metastatic phenomenon; and that it is, in fact, a true case of double primary malignancy in one breast.

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PRIMARY SUBTOTAL THYROIDECTOMY FOR GRAVES' DISEASE IN A CHILD FOUR YEARS OF AGE.*

BY E. PEARCE GOULD AND J. DOUGLAS ROBERTSON, LONDON

MARGARET L., aged 4 years, was admitted to the Middlesex Hospital in October, 1930, under the care of Dr. H. E. A. Boldero.

HISTORY.—She was a first-born child and the confinement necessitated an instrumental delivery, as the result of which the baby was severely damaged. At 4 years of age her disposition seemed to change. She became fretful and irritable; if she could not get what she wanted she would stamp and get in a temper; she tired easily and was restless during sleep; she complained of breathlessness and thirst. Three months later her mother noticed a swelling in the neck, and by this time the above symptoms had all become more pronounced.

ON ADMISSION.—Examination revealed a very excitable child, laughing and crying almost at the same time. Mentally she was precocious. There was well-marked exophthalmos and a slight fine tremor. There was no cardiac enlargement. The thyroid gland was uniformly enlarged and firm in consistence. Blood examination showed an increase in the lymphocytes:—

Red blood-cells	.. .. ..	4,480,000
White cells ..	.. .. ..	7,800
Polymorphonuclears	.. .. ..	53 per cent
Lymphocytes ..	.. .. ..	45 ,, ,,

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* From the Children's Department and the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1.

PROGRESS AND TREATMENT.—After three months medical treatment no clinical improvement had taken place, the weight remained about 34 lb. in spite of a full diet and rest, and the pulse was unchanged at 140 per minute. The basal metabolism early in December was + 45 (Benedict-Talbot standards), and a month later, at the end of the three months' medical treatment, it had risen to + 70. It was then decided that surgical intervention was necessary and the child was transferred to the care of one of us (E. P. G.). During the course of medical treatment all iodine and iodides had been carefully excluded to improve the chance of iodine ensuring such an artificial remission of thyrotoxicosis when used pre-operatively as to reduce to the minimum the risk of operation. Iodine was started in doses of 5 minims of Lugol's solution thrice daily, and the response was rapid. On the tenth and eleventh days after starting the iodine the basal metabolism fell from + 70 to − 2 and − 7 respectively, accompanied by marked clinical improvement.

FIRST OPERATION (Jan. 21, 1931).—On the twelfth day of iodine treatment a one-stage seven-eighths removal of the thyroid gland was carried out under a gas and ether anæsthetic. The operation lasted three-quarters of an hour and the patient stood it well. The portion of gland removed weighed 1 ounce, and on section presented "numerous vesicles, some containing colloid, with well-marked intravesicular epithelial growth".

SUBSEQUENT PROGRESS.—Convalescence was uneventful and she left the hospital on Feb. 27, 1931, greatly improved, with a pulse-rate of 90 and a gain in weight of 2 lb. Careful watch was kept on her as an out-patient and several B.M.R. determinations were made at intervals. During 1932 a return of the old symptoms began, and in September, 1932, her tonsils were removed. A year later, March, 1933, she was re-admitted to hospital with a left otitis media, which coincided, as shown in the chart (*Fig.* 510), with a marked rise in the basal metabolic rate. Although this cleared up under treatment, and she was gaining a little weight and growing in height, by February, 1934, the basal metabolic rate was still + 43 and a recurrence of the thyrotoxicosis was very obvious, although the exophthalmos appeared to be stationary and no more marked than on her first admission to hospital. It was then clear that further surgical intervention would be necessary, but it was hoped that this might be postponed possibly until puberty. However, during 1934 she lost a little weight, and there was no appreciable improvement in the basal metabolic rate.

ON RE-ADMISSION (Aug. 1, 1934).—At this time a definite nodule of thyroid tissue could be felt on the left side of the neck at the level of the upper pole of the gland. Iodine, which had not been taken since February, 1931, was again administered, and again the clinical response was most satisfactory, the B.M.R. falling in a fortnight from + 32 to +2.

SECOND OPERATION (Aug. 24, 1934).—Under similar anæsthesia the neck was reopened, and in addition to the nodule felt on the left side a mass of thyroid tissue was found at a similar level on the right side, but further back in the neck. Both these masses were removed, leaving behind apparently no macroscopic portions of gland. The total removed at the second operation was equal to about half that removed at the first. The patient stood this operation also extremely well, and apart from the development of mild tetany, which responded well to treatment with calcium, the convalescence was uneventful. The basal metabolism before leaving the hospital was − 4.

PATHOLOGY.—Microscopically the tissue removed was reported as showing: "Marked epithelial hyperplasia with irregular acini and numerous intra-acinar papillary projections. Many of the acini contain poorly staining colloid and show

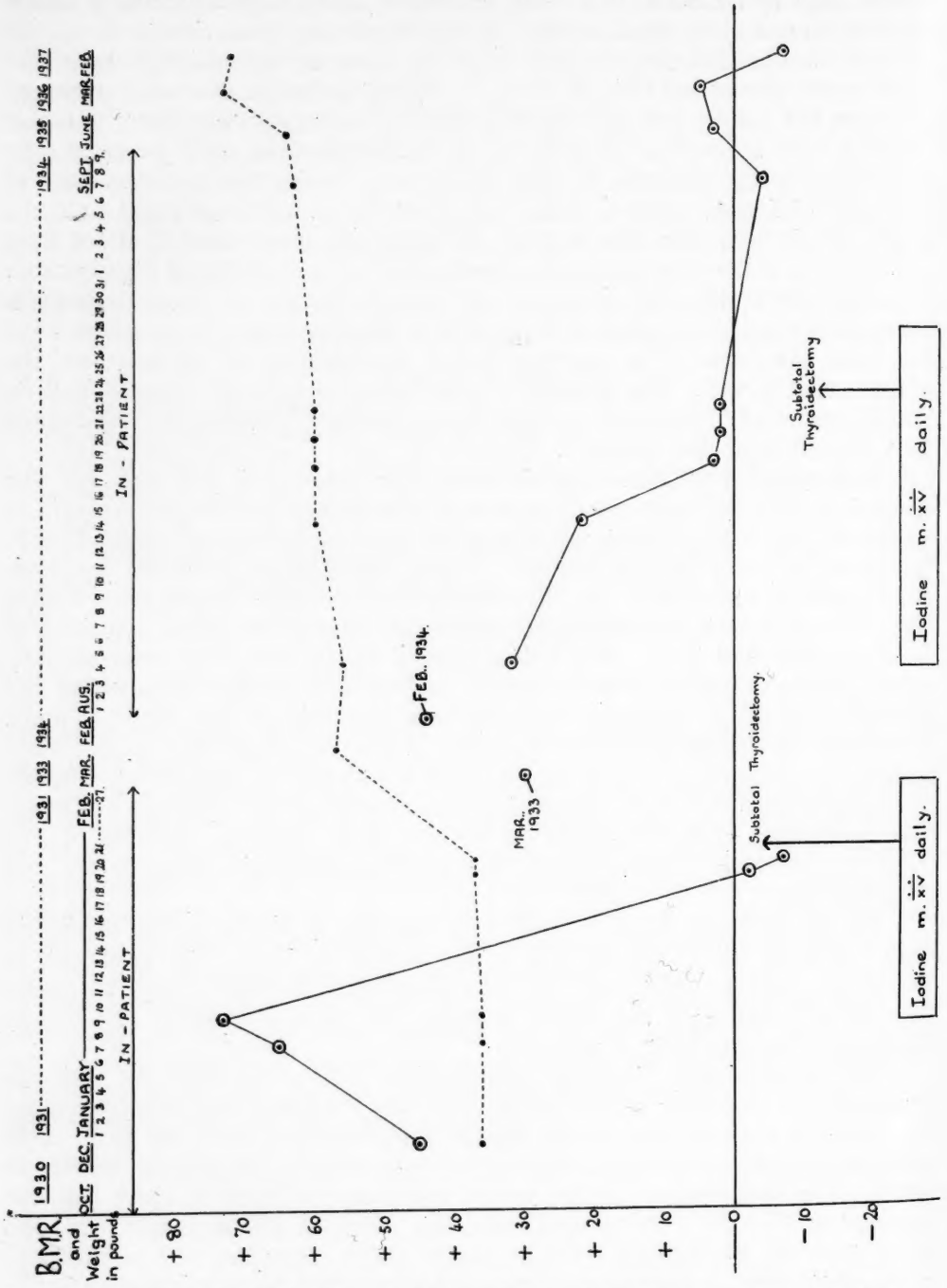

FIG. 510.—Chart showing the changes in basal metabolism and weight of the patient. The solid line and circles indicate the basal metabolism, the dotted line the weight.

evidence of 'colloid absorption', but a few contain well-formed colloid. The appearances closely resemble those of the portion of the gland previously removed with the exception that there is better colloid formation."

SUBSEQUENT PROGRESS.—Her progress was studied through 1935, 1936, and the beginning of 1937, and the improvement was maintained, as seen by the chart (*Fig.* 510). She was able to attend school, there was increase in weight, the pulse-rate remained between 80 and 90, and the basal metabolism varied between + 5 and − 7. In May, 1937, she contracted diphtheria, which was undiagnosed for three days, and she died of this disease.

Discussion.—Exophthalmic goitre in children is a well-recognized, but comparatively rare, disease. In this country individual cases have been reported by Pritchard and Stevenson (1910), Wynter (1911), White (1912), Sawyer (1916), Braid and Neale (1930), Ellis (1935), and the literature contains several excellent reviews of the condition, notably those by Lewis (1913), Helmholtz (1926), McGraw (1928), and Dinsmore (1932). It is stated to differ from the adult form in the absence of loss of weight and its occurrence without a raised basal metabolism. It has to be remembered, however, that failure in a young child to gain weight is the equivalent of loss of weight in an adult, and the statement that a raised basal metabolism does not occur is certainly not borne out by our experience in the present and other juvenile cases.

The chief interest in the condition, however, lies in the problem of treatment, and up to the present there would appear to be no unanimity on this point. The feature of note in the case here reported is that it was treated with success on exactly the same lines as are adult cases of moderate severity, with the one exception that local anæsthesia for the operation was ruled out. Fatalities have occurred with primary resection of the major portion of the gland in quite young children, and this has led surgeons to suggest that the wiser course is to precede the major operation by a preliminary ligation of two arteries; but if the ordinary rules of preparation are observed, and (1) surgery is not contemplated until medical treatment is clearly failing to control the disease, and (2) the fullest advantage is taken of pre-operative iodine medication, it would appear to be safe even in a child as young as 4½ years to proceed direct with a seven-eighths removal. Although the amount of gland removed at the first operation involved practically a total thyroidectomy, as happens now and then in adult cases, the improvement, though definite, was not maintained, and a second operation proved essential. The result of this second operation, judged by the maintenance of a lower basal metabolism, gain in weight, and ability to attend school, lasting over a period of two and a half years, gave every prospect of a permanent cure. It was obvious that even after the second operation sufficient active thyroid epithelium remained for ordinary needs. In view of the almost limitless power of hypertrophy of this tissue there remained the possibility that the stimulus of oncoming puberty, when it occurred, might have produced in this child yet a further relapse. It was hoped to continue the observations upon her until puberty had passed and later present a completed story. The tragedy of her intercurrent diphtheria has made this impossible.

Summary.—A case of thyrotoxicosis at 4 years of age, treated by primary subtotal thyroidectomy, is described. Relapse occurred and a further removal of gland tissue three and a half years later was necessary. Satisfactory progress was maintained for a further two and a half years, when death occurred from intercurrent diphtheria.

Our thanks are due to Professor McIntosh and his Staff in the Bland-Sutton Institute of Pathology for the blood and histological examinations. All basal metabolism examinations reported in this paper were carried out on a machine which was the generous gift of the Royal Socieyt.

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CANCER OF THE HEAD OF THE PANCREAS WITH ENLARGEMENT OF THE GALL-BLADDER WITHOUT JAUNDICE

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A GROWTH in the region of the head of the pancreas is always associated with enlargement of the gall-bladder and progressive jaundice due to obstruction of the common bile-duct. This fact was observed by Courvoisier. The following case illustrates only one aspect of Courvoisier's observation :—

HISTORY.—An Indian Christian, male, aged 35 years, by occupation a coolie, was admitted in 1935 for pain in the abdomen of two years' duration. He gave a history of a sore on the penis ten years prior to admission. The pain used to start in the morning and continue till 10 p.m., associated with a feeling of distension and acid eructations. Pain had no relation to food, and was mostly confined to the epigastric region. He had occasional nausea in the mornings, sometimes followed by vomiting, which did not relieve the pain. His appetite was diminished and he had lost weight considerably.

ON EXAMINATION.—The patient was poorly nourished. His abdomen was found to be scaphoid. The liver was palpable two finger-breadths below the costal margin. A soft swelling was felt in the hypochondriac and umbilical region, moving with respiration and feeling like the end of a sausage. There was no visible peristalsis. He was slightly anæmic, the teeth showed pyorrhœa alveolaris, the skin was dry, and he was *not* jaundiced. Circulatory and respiratory systems were found to be normal. The urine was normal. There were no bile-salts or bile-pigments in the urine. The blood was normal and the blood-pressure 125/90 mm. A fractional test-meal showed a delayed hyperacidity.

X-ray examination showed a notch in the region of the first part of the duodenum, a constriction between the first and second part of the duodenum,

with delayed emptying of the stomach, which was suggestive of ulceration between the first and second parts of the duodenum.

OPERATION.—Under local anæsthesia followed by general anæsthesia (ethyl chloride-ether-oxygen sequence), the abdomen was opened. A markedly enlarged gall-bladder was found. A hard, indurated, and nodular tumour in the region of the head of the pancreas was distinctly seen and felt. Though there was no jaundice cholecysto-gastrostomy was done as a palliative and preventive measure. Since there was delay in emptying of the stomach, a posterior no-loop gastro-enterostomy was done. In the mesentery of the jejunum there were few enlarged glands. The cholecysto-gastrostomy area was strengthened by a graft of omentum and the abdomen closed in layers.

Pathological report of growth showed spheroidal-cell carcinoma.

SUBSEQUENT PROGRESS.—The patient made an uneventful recovery and was discharged relieved, with advice to return if there were recurrence of symptoms. He was re-admitted in 1936, three months after discharge. He was admitted with a definite ascites and œdema of the lower limbs. Fluid was found in the abdomen, and though no masses could be felt anywhere, liver and spleen were found to be enlarged. He had no jaundice. The van den Bergh tests, both direct and indirect, were negative. Barium-meal examination showed the stoma of the gastro-jejunostomy functioning well, and in the second part of the duodenum barium was found sticking even in a 24-hour picture. He died thirteen days after admission.

POST-MORTEM FINDINGS.—Free straw-coloured fluid in the abdomen. No evidence of secondaries in the liver; the peritoneum showed no secondary deposits. Posterior gastro-jejunostomy stoma was patent and functioning well. The gall-bladder was contracted. The cholecysto-gastrostomy opening was patent. There was a growth of encephaloid type in the head of the pancreas, which extended into the second part of the duodenum, causing obstruction. The common bile-duct was patent. There was slight enlargement of the mesenteric glands. There was pressure on the portal vein. Death was due to toxæmia from the breaking down of the growth in the head of the pancreas.

Points of Interest.—

1. This case illustrates a case of cancer of the head of the pancreas without jaundice with enlargement of the gall-bladder, satisfying only one aspect of Courvoisier's law.

2. It is evident from the post-mortem examination that the absence of jaundice was due to the perfect patency of the common bile-duct in spite of the enormous growth.

MULTIPLE PANCREATIC CALCULI WITH CHRONIC PANCREATITIS

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PANCREATIC calculi are rare, and very few cases are reported in the literature. Mayo-Robson collected 80 cases; Opie found 2 in 1000 autopsies; and Moynihan reported several cases.

HISTORY.—A Hindu male, aged 39 years, was admitted for pain in the epigastric region of eight years' duration. At first the pain started in the middle of the back,

and shot forwards towards the epigastrium. Later the pain started in front of the abdomen and shot to the middle of the back, lasting for half an hour or more. It had no definite relation to food, and was relieved by taking soda water and by lying on the left side. Pain was aggravated by lying on the right side. There was no spontaneous vomiting; but if pain was severe he induced vomiting. The appetite was normal. He was not in the habit of taking his weight; he had lost weight, but could not say how much. He had no flatulence. He did not suffer from frothy stools or diarrhœa.

ON EXAMINATION.—Visible peristalsis was noticed after giving the patient a draught of water. All the abdominal organs were found to be normal. The circulatory system was normal, and the blood-pressure was 128/90 mm. The Wassermann test showed single positive. Loewi's mydriatic test was negative. A fractional test-meal showed extreme initial hyperacidity, rising to a very high concentration at the end of two and a half hours. There was 250 c.c. of starving juice before starting the test, and 120 c.c. remained in the stomach after two and a half hours. A blood-sugar test early in the morning before any food was given showed 102·6 mg. per cent.

Fat estimation showed the following:—

18·200 g. per cent of dried fæces contained:

Neutral fat with free fatty acid	3·8	per cent
Free fatty acid	1·363	per cent
Neutral fat	2·437	per cent
Combined fatty acid	14·4	per cent

The urine was normal, except for the diastase content, which showed 10 units.

X-ray examination revealed a large number of stones along the course of the pancreas. A barium-meal examination showed a delay in the emptying of the stomach.

OPERATION.—After opening the abdomen under local anæsthesia combined with general, the pancreas was found to be hard from head to tail. On cutting into the duct, glairy fluid came out; there was very little bleeding and the gland cut like cartilage. Three hard calculi were removed; there were also innumerable calculi in the canaliculi, but it was found difficult to remove all of them. The duct was drained from both the head and tail end by a No. 10 catheter, and the duct was sutured water-tight and peritonized carefully, and the lesser sac marsupialized and drained separately.

The patient died on the third day. There was free drainage from the drainage tubes in the pancreatic duct. On biochemical analysis the fluid collected was found to contain all the enzymes of the pancreas. Post-mortem examination was not done, as permission was not given.

Points of Interest.—

1. There was an innumerable number of calculi. Pain originally started from the middle of the back, shooting forwards to the epigastrium; later it started in front and shot to the back, getting worse if the patient lay on his right side. He had visible peristalsis.

2. The gastric analysis showed a very high acidity curve. Is this due to partial blocking of secretion from the pancreas to the duodenum? Clinical investigation showed no evidence of complete blocking or deficiency of secretion.

3. The diagnosis of pancreatic calculi was made by X-ray examination, and not from the signs and symptoms.

MULTIPLE INTUSSUSCEPTIONS IN A CHILD

By W. G. GILL

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INTUSSUSCEPTION in children is a sufficiently frequent catastrophe to be well known, and that a small percentage are ileo-ileal is also generally recognized. Rarer types are occasionally seen, but a perusal of the literature has failed to discover a case similar to that to be described.

HISTORY.—The patient, a female child, aged 19 months, had been quite well until the morning of the day of admission to hospital. On this day, because the child was constipated, her mother gave her a vegetable purge. This was shortly followed by a bowel action, and soon after the child seemed to be in great pain, becoming pale and drawing up her legs. The attack soon passed off, to be followed by another two hours later, when she was brought at once to hospital.

ON EXAMINATION.—When the child was examined in the ward the temperature was 99° F, the pulse 120 per minute, and the respirations 20 per minute. She had vomited once since admission, but not before. Normally a robust and healthy infant, the child was pale and listless and was lying quite still in bed. As soon as the abdomen was palpated she became irritable, but did not resist examination. The abdomen was supple, but distended in its upper half. Apart from the spleen, which was palpated, there was an indefinite tumour in the left hypochondrium. During the examination the child gave a scream, and at the same time the tumour became definite and hardened under the hand. The same phenomenon was noted again a little later. Two enemata were given, the first producing a little fæcal matter with blood and mucus, the second blood and mucus only. Nothing abnormal was detected on rectal examination. A diagnosis of acute intussusception was made.

OPERATION.—A laparotomy was performed under general anæsthesia. Opening the abdomen through a right paramedian incision, coils of distended small intestine were first seen, and in the left hypochondrium, instead of the expected ileocolic intussusception, six or seven separate ileo-ileal intussusceptions were found close together. The first one had progressed for about 2 in., causing obstruction and distension of the bowel proximal to it. Distal to this one there were other smaller intussusceptions. All were easily reduced, and only the first showed any signs of congestion in the bowel wall. It was noticed that after reduction the intestine was undergoing active peristalsis, and was even trying to reproduce the intussusceptions.

The only other finding of note was the presence of large matted glands in the mesentery opposite the affected area of intestine, and these were thought to be tuberculous.

The abdomen was closed, and four-hourly injections of atropine sulphate (gr. $\frac{1}{150}$) were instituted for twenty-four hours.

PROGRESS.—The child developed whooping-cough on the third post-operative day, with the result that a small ventral hernia appeared. Except for this, she was discharged well on the tenth day to a fever hospital.

I wish to thank Mr. Lancelot Bromley for permission to publish this case.

REVIEWS AND NOTICES OF BOOKS

Post-graduate Surgery. Edited by Rodney Maingot, F.R.C.S. In three volumes. Royal 8vo. Vol. III. Pp. 3573–5584, with 994 illustrations. 1937. London: Medical Publications Ltd. £9 9s. the set, or £3 10s. per volume.

THIS is certainly one of the most weighty volumes on surgery (8 lb. 10 oz.). It represents the final part of a great work, which, in spite of many glaring defects, still deserves the praise and admiration which we expressed about the first volume. There are many articles of outstanding merit which themselves make it worth while to have the whole work.

Ogilvie gives a very good account of hernia, and it is surprising with what freshness he describes this rather dull subject. The use of fascia and of dermal grafts is particularly well described and illustrated. It is good to have this first-rate paper after reading in an earlier volume the advocacy of treating hernia by injections.

Plastic surgery is described by Kilner in an article every word of which is worth reading. The details of grafting by different methods, and the use of slips of fascia in facial surgery, afford most useful information in various practical problems. The methods of repair of cleft palate are on the lines of Veau's operation as described by Wardill, and we note with interest and some surprise that the Gilles operation has no mention.

Bourne deals with obstetric surgery. We should have thought that in this connection the operation of episiotomy would have deserved both description and illustration.

Another chapter full of new information is that on cardiovascular surgery by Cokkinis. The surgery of the heart seems to unfold great possibilities for future development. We are disappointed that the omental heart graft has not received more notice.

An article of less than 300 pages on orthopædics is contributed by Buxton. It is prefaced by a note saying that in future editions this subject will have a volume to itself, in place of the present very unsatisfactory arrangement by which certain subjects were placed in the second volume and others in the third. Even putting the two series of articles together the subject is very incompletely dealt with. For example, scoliosis is not even mentioned. There is a clear and well-illustrated account of different methods of arthroplasty and arthrodesis. It is rather remarkable that in describing the operations for recurrent dislocation of the shoulder four difficult and complicated methods should be described, whereas the simple and efficient method of treatment by a fascial sling is not even referred to.

Another article of outstanding merit because of its full and clear account of recent work is that by O'Shaughnessy on the œsophagus and diaphragm.

There are special chapters on the eye, ear, nose, tongue, larynx, and pharynx by specialists in each of these subjects. There are also a number of chapters on subjects of general surgical interest, apart from topical surgery. Such are: medical aspects of surgery, physical medicine, endoscopic methods, aspects of general surgery, which includes varying subjects such as shock, drip-blod transfusion, gangrene, burns, peri-anal suppuration, and lumbar puncture, and lastly some neurological and psychiatric aspects of surgery. The last article, however, makes no reference to cordotomy, and as judged by the Index this subject is nowhere else mentioned in the book.

It only remains now to say a few words about the work as a whole. As we said in reviewing the first volume, we are greatly impressed with the enterprise and energy of the Editor and his collaborators. They have attempted a most ambitious task and have produced a work of outstanding merit. Our most serious criticism is the arrangement of the various subjects dealt with. Obviously this has been already realized by the editorial board in the matter of orthopædics, and we hope that the odd subjects dealt with under aspects of general surgery will in future editions be placed in their proper position. It will at once take its place as a standard book of reference essential to every medical library, and we heartily congratulate the Editor on having produced this monumental work as his first essay in surgical literature.

Traité de Chirurgie orthopédique. Published under the direction of Professors L. OMBRÉDANNE and P. MATHIEU; Editorial Secretaries, M. LANGE, G. HUC, and P. PADOVANI. In 5 volumes. Large royal 8vo. Vol. II. Physiology, Pathology, and General Treatment (*contd.*); The Spine. Pp. 1016, with numerous illustrations. Vol. III. The Spine (*contd.*); The Upper Extremity. Pp. 952, with numerous illustrations. Vol. IV: The Pelvis; The Lower Extremity. Pp. 904, with numerous illustrations. Vol. V: The Lower Extremity. Pp. 716, with numerous illustrations. 1937. Paris: Masson et Cie. The whole work, Fr. 1100; bound, Fr. 1250.

IT is very difficult to do justice to a work of this magnitude in the space at our disposal.

Volume II is divided into two parts: the first dealing with general principles of physiology, pathology, and treatment, and the second with the spine. Professors Rocher and Nové-Josserand and Dr. Brunat write about the different types of paralysis, spastic and infantile. In this as in so many sections of the work the numerous illustrations are well drawn and apt, but in particular we are attracted by the excellent little diagrams which contain so much information in a small space, e.g., the *Fig.* 3 on p. 923 of the varied operations for spastic paralysis—fourteen pictures on one page form a synopsis of the whole subject. Nerve injuries are described by Professor Petit-Dutaillis, who gives a critical account of the subject of nerve-grafting. Chapters on apparatus and plaster, radiodiagnosis, remedial exercises and physiotherapy are included in this part.

The second part, on the spine, comprises 700 pages and contains notable articles by Huc, Sorrel, and Madame Sorrel-Dejerine. Here again, the pictures of physical exercises made of little robot figures are both attractive as well as most clear in their meaning. The space assigned to various subjects does not seem to be in proportion to the importance of these. For example, chronic spinal arthritis has thirty-three pages, the pathology of the intervertebral discs has twenty-four, whilst Pott's disease has only sixty-four. This article on spinal tuberculosis is very sound. The pictures of spinal cord lesions and discussion of paraplegia are most excellent, but we could wish that the lesions as seen by the X rays could be better reproduced.

Volume III, like each of the other volumes, has a most intriguing frontispiece—these are taken from old Græco-Roman treatises, the one in this volume depicting one method of reduction of a dislocation of the shoulder. The subject of the spine is concluded by Professor Petit-Dutaillis with an article on new growths of the vertebral column. He gives some remarkable figures and descriptions of angiomata of the vertebræ and also a good account of fibromas arising from backward dislocation of the discs.

The bulk of the volume consists of a description of the upper limb—its anatomy, physiology, pathology, and treatment.

The article by Huc and Oberthur on the shoulder girdle is notable for the beautiful anatomical drawings. Acromio-clavicular dislocation is described at great length with a complete description of its operative treatment, including the use of a fascial sling round the coracoid and acromion. Tavernier's article on dislocations of the shoulder gives prominence to the Clairmont muscle sling operation, which has been found quite ineffective, and the complicated Henderson procedure, whilst the simple fascial sling is not mentioned. Ombrédanne describes the anatomy and treatment of that rare anomaly, congenital dislocation of the shoulder, all of which is quite new to us.

The rest of the upper limb is dealt with by a number of authors who leave very little unsaid on the subject. They give every type of fracture, dislocation, and disease which may affect this limb. Dr. Mouchet, in describing the operative exposure of the lower end of the humerus, omits the method of splitting the tendon of the triceps, which saves the cutting of the olecranon. Arthroplasty of the elbow-joint is a more or less simple excision, the use of muscle or fascial coverings not being considered necessary.

The section on the hand is one of the best in the book, for the most part being written by Dr. Iselin. The anatomical drawings and the physiology of movements are very clearly illustrated by perfect line drawings. It is most interesting to find the French view of Dupuytren's contracture fully described. The only treatment worth while is the careful and complete excision of the entire sheet of palmar fascia with all its off-shoots, together with skin grafting. The steps of this procedure are well illustrated.

Volume IV is concerned with the pelvis and the lower limb. In this as in other volumes there is a remarkable record of rare types of congenital abnormalities—e.g., absence of the sacrum.

Professor Le Fort and Dr. Jean Minne, in describing the anatomy and physiology of the

pelvis, give clear and instructive line drawings of the movements possible at the sacro-iliac joint. Very clear line drawings are given of the three chief ways of obtaining arthrodesis of the sacro-iliac joint.

There is a series of articles on dislocation of the hip, Professor Mathieu opening with a description of different lines of approach, and Dr. Marcel Lance giving an exhaustive account of the condition in all phases of its development. The shelf operation and various types of osteotomy are very well described and illustrated. Possibly there is too much detail about methods of manual reduction. A special section deals with subluxation, and Calvé himself later on discusses coxa plana. Dr. Marcel Lance also deals with the subjects of coxa vara and valga. We had not appreciated the fact that congenital coxa vara was so common. The coxa vara caused by slipping of the epiphysis is treated by bone-pegging.

Fracture of the neck of the femur is by Professor Mathieu. He advocates the Smith-Petersen nail, which is guided into its place by a rather complicated instrument looking like a sextant.

Dr. André Richard, of Berck, writes about hip disease and gives an account which is both complete and up to date. The pictures of bone flaps for arthrodesis are particularly noteworthy as being the ideals of what such figures should be.

The knee is the subject of various articles, of which two only need be commented on. Tavernier gives a description and drawing of excision of the meniscus by a transverse incision with complete division of the lateral ligament. The French have employed and figured this for many years, whilst English surgeons would regard deliberate division of the lateral ligament as a grave error. Delahaye describes a method of extra-articular arthrodesis of the knee, which is suitable for tuberculous disease, and is on the same lines as the fusion used for other joints—e.g., the hip. It consists in placing a bony bridge from the femur to the tibia right over and including the patella.

Volume V concludes the work with a consideration of the leg below the knee, the ankle and foot, and amputations, some legal considerations in assessing degrees of disability, and "the orthopædic boot". The section on the leg is written by Professor Rocher and by Dr. Boppe. It is notable for the full discussion of congenital malformations and the treatment of congenital pseudarthrosis of the leg bones. Osteosynthesis is given as an alternative to traction methods for treating fractures, but figures are quoted which show a large proportion of accidents and bad results. Dr. Lucien Michel writes the most important chapter on club-foot, giving full details of treatment by manipulation and operation. Apparently in the matter of splintage there are many varieties of splints which hold both feet connected with one another in any angle of abduction and rotation, such as we associate with the name of Denis Browne in this country.

The various stabilizing operations on bones and nerves for the treatment of paralytic feet are described by Drs. Lance and Bertrand, but we would like to know to what extent results justify the tendon transplantations which have so largely fallen into disuse here, because the solid bony foot seems to be so much more satisfactory. The various methods of muscle and tendon transplants for paralysis of the hip muscles are well illustrated and make reference easy.

We conclude the perusal of this great work with a feeling of gratitude to the editors and authors for their devotion to a common cause. They have produced a monumental work which will be the standard of reference for many years.

The standard of illustrations is very high, and this applies especially to the line drawings and the diagrams. But we wish that the figures were numbered consecutively throughout the work. The only notable omission in the book is an account of the technique and indications for sympathectomy—which is only mentioned very casually in Volume I. Renal rickets too deserves more than the few lines which it receives.

We tender to editors, authors, and publishers our most cordial congratulations on their splendid achievement.

The Art of Surgery. A Text-book for Students and Practitioners. By H. S. SOUTTAR, D.M., M.Ch. (Oxon.), F.R.C.S. (Eng.), Surgeon, London Hospital. Third edition. 9¾ × 7¾. Pp. 630 + x, with numerous illustrations and 12 coloured plates. 1937. London: William Heinemann (Medical Books) Ltd. 30s. net.

THIS book retains the originality and uniqueness on which we commented in the first edition. It is remarkable that nowadays one surgeon can undertake to write and also largely to illustrate a text-book of surgery single-handed. Such a book will always have a charm which is absent

in works by many writers. But then against this charm we have to put the fact that one surgeon is usually not in touch with every branch of his art and therefore gives but a poor account of those subjects which he is not personally dealing with. A glaring example of this is in the sections on fractures. In fracture of the neck of the femur we are told that the ideal treatment is that by a walking calliper. Cases of Pott's fracture with slight displacement are treated by just laying the leg on its outer side and following this by massage and passive movements. This out-of-date teaching is not atoned for by an appendix of two pages on " the modern treatment of fractures ".

However, in the main the author's aim of stressing important things and leaving out unimportant has been achieved, and the resulting work is very readable and instructive. We like the line drawings, but we do not like those in colour.

Surgery of the Sympathetic Nervous System. By GEORGE E. GASK, C.M.G., D.S.O., F.R.C.S.Eng., Emeritus Professor of Surgery, University of London; Consulting Surgeon, St. Bartholomew's Hospital; and J. PATERSON ROSS, M.S. Lond., F.R.C.S. Eng., Professor of Surgery, University of London; Surgeon and Director of the Surgical Unit, St. Bartholomew's Hospital. Second edition. Large royal 8vo. Pp. 186 + xii, with Frontispiece and 49 illustrations. 1937. London: Baillière, Tindall & Cox. 16s.

THE opportunity to read a second edition of this work is welcome. The changes in this edition would appear from the preface to be the work of Paterson Ross, and they have, on the whole, brought the book up to date and have increased its value. The work has been enlarged from 159 pages in the first edition to 186 in the present one. Certain of the sections have been not only re-written but also re-arranged, we think, with advantage.

In a subject showing so many facets as does sympathetic surgery at present, it would be easy to comment on omissions, but within its limited pages the work deals with most aspects of the subject in a competent, restrained, and judicial fashion, especially evident in the new section on cardiospasm. We have but two comments to make. The notable work of White in applying Lewandowsky's observation on the effect of intravenous adrenaline is briefly mentioned, but there is not sufficient discussion of preganglionic methods. The statement is made on page 82 that " the only satisfactory method of removing the sympathetic supply to a limb is by ganglionectomy ", but there are surgeons of experience both here and in America who would not subscribe to this view. The second comment is that perivascular sympathectomy does not, to-day, merit 20 pages out of a total of 186.

A Practice of Orthopædic Surgery. By T. P. MCMURRAY, M.B., M.Ch., F.R.C.S. (Edin.), Director of Orthopædic Studies and Lecturer in Orthopædic Surgery, Liverpool University, etc. Demy 8vo. Pp. 471 + viii, with 178 illustrations. 1937. London: Edward Arnold & Co. 21s. net.

WE have nothing but praise for this, the latest contribution to the rapidly growing number of orthopædic text-books. It has two very outstanding merits: first, the author has chosen his material very wisely, so that all the essentials and common matters are dealt with, whilst rare and controversial matters are omitted. In this way it has been possible to produce a wonderfully complete book on the subject in less than 500 pages. Secondly, in matters both of description and illustration the book is perfectly clear and readable.

Having been for many years associated with the late Sir Robert Jones, the author gives an account of his subject which he learnt from the great master. It is rather refreshing, for instance, to see the various splints and appliances invented by Thomas and popularized by Jones given a full description at a time when it is fashionable to use nothing but plaster-of-Paris for bone and joint surgery. We appreciate the reason why the subject of fractures is not included, but we think that a future edition should discuss the treatment of open, malunited, and ununited fractures, and that the last should include a description of the methods and technique of bone-grafting.

The author purposely refrains from giving many alternative methods of treatment or operation, and contents himself with describing those methods which he himself considers best. This, of course, makes for clear teaching, but we think that perhaps this principle has been carried a little too far. For example, he advocates the removal of the base of the first phalanx in the treatment of hallux valgus, without mentioning the more commonly performed

operation of excision of the metatarsal head. He describes the operation for bone lengthening, confining himself to the case of the femur. After making the usual Z-shaped division of the bone, extension is applied by a Thomas splint and presumably adhesive plaster for eight weeks. No mention, however, is made of the commonly used double transfixion methods with screw distraction.

We are sure that the book will achieve a wide popularity—first, because of its intrinsic merits, and, second, because it represents the latest exposition of Robert Jones's teaching.

Die Drahtextension. Anleitung zum praktischen Gebrauch. By Prof. Dr. RUDOLF KLAPP and Dr. W. RÜCKERT. 9⅝ × 6¼ in. Pp. 146 + viii, with 185 illustrations, some in two colours. 1937. Stuttgart: Ferdinand Enke. RM. 14; bound, RM. 15.80.

THIS is a very clear and well-illustrated account of the origin and application of skeletal traction by means of the taut wire, which is usually known as Kirschner's wire in this country. It was first used by Klapp in 1913 in the second Balkan war and much more extensively in the World War. The essential factor is that the wire must be held taut in a metal horseshoe. Stainless steel should be used as it gives the minimum of tissue reaction. The diagrams of the methods of its use are so clear that they convey the meaning to anyone not conversant with the text. Two points are especially well proved: one is the value of the wire traction in fractures above the elbow, the olecranon being perforated; the other is the possibility of achieving lateral and rotatory correction by means of the wire, when traction is also used.

The more complicated applications of wire traction in correcting deformities of the knee and foot are perhaps less convincing and more open to criticism. The monograph is a model of clarity and brevity.

Allgemeine und spezielle chirurgische Diagnostik. Ein Lehrbuch für Studierende und Ärzte. By Professor Dr. MAX KAPPIS, Würzburg. Second edition. 10 × 7½ in. Pp. 736 + xx, with 545 illustrations in text and 5 coloured plates. 1937. Berlin and Vienna: Urban & Schwarzenberg. RM. 23; bound, RM. 25.

THIS is a very comprehensive treatise on surgical diagnosis. It is divided into three parts. In the first part are discussed the general principles of diagnosis. In this is included a discussion of both constitutional and local abnormalities, the former even taking into consideration the smell of the patient. The second part deals in a systematic way with the diagnosis of general surgical diseases, or, more properly speaking, the diseases of various tissues. The third part is concerned with the diagnosis of abnormalities of different organs and parts of the body.

The whole book shows that there has been a very careful selection of illustrative cases taken from a very wide clinical experience over many years. Not only are there typical examples of all common diseases, but also many rare conditions are mentioned, with a short and accurate description. For example, we have never before seen an illustration of Caisson's disease as affecting the head of the femur; and such an unusual condition as the snapping hip is accurately described. The outstanding feature of the book, however, is the wonderful collection of illustrations, which will make the work of great interest and value, even to those who do not read German. The coloured illustrations are chiefly confined to pictures of the mouth and tongue, and there are also some very excellent pictures which combine a coloured cystoscopic picture with a drawing of the associated kidney condition. It is a pity that the subject index at the end is not quite complete, so that although caisson disease is well described and illustrated, it is missing from the index.

We regard this as a most valuable book of reference and hope that it may be translated into English.

Text-book of Gastroscopy. By NORBERT HENNING. Translated by HAROLD W. RODGERS, F.R.C.S., St. Bartholomew's Hospital, London. Crown 8vo. Pp. 86 + xii, with 26 illustrations in the text and 7 coloured plates. 1937. London: Oxford University Press. 7s. 6d. net.

GASTROSCOPY owes a great debt to Professor Norbert Henning. A co-worker with Schindler, he played an important part in the planning of the now famous Wolf-Schindler flexible gastroscope, and in popularizing its use at his clinic at Leipzig, and subsequently at Fürth.

The large number of foreigners who visited him during his career at Leipzig must have been impressed with his skill as a gastroscopist, no less than with his readiness to extend to them the full benefit of his experience. Many young men from British clinics were privileged to work with him for a time before taking up the study of gastroscopy in this country, where, after a lengthy period of probation, it has become now an established method of procedure, and in use at some thirty clinics throughout the land. Henning's little book—published in the original over two years ago—is no stranger to us, but it is a very great convenience to have a ready-made translation to hand. Mr. Rodgers has accomplished the task in praiseworthy fashion, for he has produced a translation which is both literal and readable—a rare and happy combination.

The book, a convenient pocket volume containing eighty-four pages, deals briefly yet completely with the subject. No words are wasted in irrevelant detail, nor over matters of controversy. The history of gastroscopy and the optical principles involved in both the rigid and flexible types of instrument are fully described, and the technique of the examination is given in the most practical and helpful manner. The section on gastritis is of especial value. The author has avoided falling into the trap of attempting a rigid classification of the various types of diffuse lesions of the stomach, but has instead adopted a simple grouping based solely upon the appearance of the mucosa as seen through the gastroscope. Despite Henning's enthusiasm for gastroscopy, he does not omit to discuss the limitations of the method, and one is impressed with the fair and scrupulous way in which he assesses the value of the examination to clinical medicine. The book is adequately illustrated, and contains many pictures in colour, some of these being coloured photographs obtained through the rigid type of gastroscope.

The book is not only an invaluable aid to the beginner—who should not be without it—but contains much that will be appreciated by those who have already acquired some experience of gastroscopy.

Gastroscopy: The Endoscopic Study of Gastric Pathology. By Dr. RUDOLF SCHINDLER, Associate Clinical Professor of Medicine, University of Chicago. With a Preface by Dr. WALTER LINCOLN PALMER, Associate Professor of Medicine, University of Chicago. $9\frac{1}{2} \times 6\frac{3}{4}$. Pp. 343 + xiii, with 89 text figures and 8 coloured plates. 1937. Chicago: University of Chicago Press. (London: Cambridge University Press.) 34s. net.

THIS is the first modern text-book dealing with this subject to be written primarily in English. It is not a translation of the author's *Lehrbuch und Atlas der Gastroscopie*, but is based on the practical knowledge gained from the performance of over 3000 gastroscopies.

The whole subject is discussed with amazing detail in twenty-one chapters, which include history, anatomy, physiology, technical problems, technique, and various physiological and pathological headings. The various types of gastroscopes are described, together with the advantages of the modern flexible gastroscope used by the author. There are separate chapters on the relationship between gastroscopy and surgery, gastrophotography, histology and radiology. The relationship between the latter is thoroughly discussed both in the special chapter and throughout the book. The fact that they are not antagonistic but essential and the two most valuable methods of investigation is stressed. The difficulties of technique and the interpretation of what is seen are both fully explained and discussed. Not only are gastroscopic appearances described, but also the symptomatology and treatment of various pathological conditions.

As would be expected, there are some minor points with which one is not in full agreement, such as the statement that the passing of a stomach tube is essential before a gastroscopic examination. The micro-photographs are excellent, and there is a good bibliography. The coloured photographs are rather disappointing and not up to the standard of the rest of the book. One would prefer to have the picture opposite the subject matter instead of all being included together at the back of the book. The pictures themselves are not a good reproduction of the true colours seen with the gastroscope, and a number of them have a tendency to be too diagrammatic and therefore appear lifeless.

Despite this criticism one feels that the reading matter alone will make this book a standard text-book to which all gastroscopists will often turn for help and guidance.

Thoracic Surgery. By FERDINAND SAUERBRUCH, Professor of Surgery in the University of Berlin, and LAURENCE O'SHAUGHNESSY, F.R.C.S., Hunterian Professor in the Royal College of Surgeons of England. A revised and abridged edition of Sauerbruch's *Die Chirurgie der Brustorgane*. Imp. 8vo. Pp. 394 + viii, with 215 illustrations and 16 coloured plates. 1937. London: Edward Arnold & Co. 50s. net.

THE surgery of the thorax, in common with that of many other branches of our art, received a great impetus during the war, when injuries to the heart, lungs, and mediastinum were of such frequent occurrence. Following war experience the practice of thoracic surgery has developed considerably and become widespread; another important factor to which it has owed its rise has been the development of differential pressure anæsthesia, whereby respiration may be maintained while the chest is laid widely open to atmospheric pressure; but by no means the least important factor has been the pioneer work of men such as Professor Sauerbruch and his associates, whose experiences are here recorded.

This work is really a revised and abridged edition of Sauerbruch's *Die Chirurgie der Brustorgane*, and English-speaking surgeons must be indebted to Mr. O'Shaughnessy, by whose collaboration with Professor Sauerbruch it has been produced. It comprises an account of the surgical anatomy of the thorax and its contents, details of the pathology of chest diseases and their prognosis, and a description of operations and the after-treatment of patients operated upon. A valuable inclusion is a series of case histories briefly but graphically reported, and illustrating the application of particular methods of treatment. For the most part the methods described are those of the Sauerbruch clinic, but space is found for reference to other procedures practised elsewhere, and for this reason this volume may be regarded as a comprehensive account of the modern practice of thoracic surgery.

The type is large, clear, and easily read, and both the text illustrations and the whole-page plates, some of which are coloured, are excellent. The same may be said about the X-ray reproductions. The historical introductions to certain of the sections add much to the interest of the reading and constitute a practice which might be followed with advantage by other writers of text-books. It is pleasing to notice the use of the terms 'parapneumonic' and 'metapneumonic' in reference to thoracic empyema, but not all will agree with the observation that thymectomy is indicated if the general symptoms of Graves' disease are present but without enlargement of the thyroid, and also in those cases which partial thyroidectomy has failed to relieve. For the most part, however, controversial subjects are discussed in such a form that the reader feels the evidence has been carefully sifted and impartially treated.

In addition to an index of both subjects and authors, there is a bibliography divided into sections, e.g., surgery of the thoracic œsophagus, surgery of the diaphragm. An appendix deals with the surgical treatment of cardiac ischæmia, which is also discussed in the chapter on the surgery of the heart and pericardium.

While this work will no doubt appeal essentially to thoracic surgeons, it should also prove an attractive addition to the library of the general surgeon, for herein he will find valuable help in his problems relating to surgery of the chest.

Einführung in die Ventrikulographie. By Dr. BENNO SCHLESINGER. Large royal 8vo. Pp. 246 + xii, with 146 illustrations. 1937. Berlin and Vienna: Urban & Schwarzenberg. RM. 18; bound, RM. 20.

THE importance of ventriculography cannot be exaggerated for giving useful information regarding tumours of the brain, and the literature which has sprung up on this subject is prolific. The present monograph by Dr. Benno Schlesinger points out the importance of ventriculography not only to the neurologist but to the neuro-surgeon.

As ventriculography is being more extensively used there is a definite improvement in the technique used by radiologists, and more detail regarding the third and fourth ventricles is coming to hand. The difficulties which exist in X-ray diagnosis of cerebral disease are essentially of a practical nature. Frontal lobe tumours for the most part are silent tumours and give rise to few localizing symptoms. However, they always produce sooner or later a deformity of the anterior cornu of the lateral ventricle. A tumour in the occipital lobe similarly distorts the posterior cornu, and these may be the only diagnostic signs of the localization of such tumours. Although certain X-ray photographs demonstrating various

deformities of the ventricular system have been incorporated in this book, the author uses for the most part pencil drawings to illustrate the irregularities of the different parts of the ventricles.

The book is the outcome of co-operation between surgeon, neurologist, and radiologist —the ideal combination for the furtherance of knowledge on this subject. The book will prove of interest and value to all neurologists and neuro-surgeons who are interested in this particular branch of X-ray diagnosis.

Die Technik der Operation der Gaumenspalten und Gaumenlippenspalten nebst Ergebnissen. By Dr. K. LUHMANN, Oberarzt der Chirurg, Universitätsklinik, Breslau. 9⅜ × 6⅝. Pp. 99 + vi, with 170 illustrations. 1937. Leipzig: J. A. Barth. RM. 9.60.

THIS is an excellent little monograph giving the author's experience during the past few years in operating on 320 cases of hare-lip and cleft palate.

It is remarkable that during the last ten years the practice with regard to cleft palate surgery has completely changed, so that Langenbeck's, Lane's, and Brophy's methods are now only of historical interest. It is not the median defect in the palate, but the posterior defect as between the soft palate and the pharynx which is the important part of the lesion in respect to function. The French surgeon Veau deserves most of the credit for the clearer understanding of principles, and the consequent improvement in practice which has followed. The present book acknowledges this, and it is largely an exposition of Veau's method, with a discussion of technical details and an analysis of results.

Luhmann operates on the lips at from three to five months and on the palate at from eighteen to twenty-two months. The description and illustrations are concerned mostly with the formation and suturing of flaps, and we think that more attention might have been devoted to the equally important points of mobilization of the soft palate from the hard, and of some plastic operation on the pharynx.

In giving results, too, the only stated criterion of success is the cure of the cleft or the existence of a residual defect. No table of results is complete without mentioning and classifying the quality of speech produced.

Wundheilung. By Prof. Dr. WILHELM LÖHR, Direktor der chirurgischen Klinik des städtischen Krankenhauses Magdeburg-Altstadt. Imperial 8vo. Pp. 234 + vi, with 141 illustrations. 1937. Leipzig: J. A. Barth. RM. 21; bound, RM. 23.

THIS is a most excellent monograph on the practical methods of treating wounds. The method is founded on three principles: (1) Absolute immobilization of the wounded part by plaster-of-Paris; (2) Prevention of contamination by dressing, packing, and drainage; and (3) Cod-liver oil applied to the wound. The first two principles are on the same lines as Winnett-Orr's treatment; it is the careful and thorough exposition of the value of cod-liver oil which is the most interesting part of the work. The vitamin theories of the action of this agent are explained and animal experiments detailed. The practical application of the method is given for all types of wound. Usually the cod-liver oil is mixed with vaseline and applied as a gauze tamponade in deep and dirty wounds. Examples are given of all these types of wound, showing how infection is avoided and regeneration encouraged.

Scritta di Chirurgia erniaria. In commemoration of the fiftieth anniversary of Bassini's operation. Collected and edited by G. M. FASIANI and A. CATTERINA. In two volumes. 9⅛ × 7¼ in. Pp. 1172, with several illustrations. 1937. Padua: Tipografia del Seminario di Padova.

THESE volumes are published to commemorate the fiftieth anniversary of the introduction by Bassini of his method of operating on indirect inguinal hernias. The contributions are by sixty-five Italian and twenty-eight foreign surgeons.

The work opens with a short eulogy of Bassini's achievement by Professor Valgimigli, of the Faculty of Arts of the University of Padua. In his story he relates the part Bassini played as a young man in Garibaldi's campaigns, and speaks of the bayonet wound in the groin from which the young surgeon recovered only after a year's severe illness.

The succeeding pages reproduce Bassini's original papers on the cure of inguinal (1889) and femoral hernias (1893).

Among the names of foreign surgeons contributing to the symposium, are to be found those of Bevan, Buchanan, Coley, Lewis, Mayo, and Wilkie; Ludwig, v. Eiselsberg, Gold, Payr, and Zimmerman; Duval, Gregoire, and Ombrédanne; Groth, Ishihara, Shiota, Peičič, Schoemaker, and Wojcieckowski; whilst the Italians naturally flock from all quarters to celebrate the work of a fellow-countryman that has been adopted and prosecuted the world over.

In these volumes one finds a multitide of minor deviations from the precise details of the original procedure, but all are based upon, and all acknowledge, the fundamental perception of anatomy and physiology that have enabled this operation to persist as the main type throughout fifty years of unprecedented progress in surgical technique.

Demonstrations of Physical Signs in Clinical Surgery.—By HAMILTON BAILEY, F.R.C.S., Surgeon, Royal Northern Hospital, London; Surgeon and Urologist, Essex County Council, etc. Sixth edition. Demy 8vo. Pp. 284 + xii, with 358 illustrations, many of which are in colour. 1937. Bristol: John Wright & Sons Ltd. 21s. net.

WHEN a book has run into its sixth edition within ten years, it is hardly necessary to write any commendation and superfluous to make any criticism. It represents the kind of notes which might make the basis of a surgical tutor's practical classes, and it is so well illustrated as to make it very easily read and remembered. The colour figures, especially those taken from colour photographs, are very artistic.

The book is not without a touch of humorous imagination, as when, for example, the quotation of the seven ages of man (*As You Like It*) is given to emphasize the different causes of retention of urine.

It is useful to have a book like this to teach that diagnosis can often be made by simple observations of physical signs without reference to complicated apparatus or laboratory tests.

Elements of Surgical Diagnosis. By Sir ALFRED PEARCE GOULD, K.C.V.O., C.B.E., M.S., F.R.C.S., Late Surgeon to the Middlesex Hospital, etc. Eighth edition, revised by ERIC PEARCE GOULD, M.D., M.Ch. (Oxon.), F.R.C.S. (Eng.), Surgeon to the Middlesex Hospital, etc. 6¼ × 4 in. Pp. 718 + xvi, with 22 plates. 1937. London: Cassell & Co. Ltd. 10s. 6d. net.

IT is more than fifty years ago since this book was first published. Its author had a gift for clinical teaching which amounted to genius. In the main the immutable principles which he laid down remain as the basis of the present edition: careful examination and thoughtful deduction must form the basis for diagnosis, whilst laboratory methods should be only supplementary.

The chief new features of the present edition consist in additional emphasis on X-ray evidence, the majority of the plates being reproductions of radiographs; intravenous pyelography; the X-ray evidence of meningioma, subphrenic abscess, and intestinal obstruction.

It is remarkable how so much valuable information has been packed into a little book of so handy a size.

Sportschäden und Sportverletzungen. By Prof. Dr. BURGHARD BREITNER, Innsbruck. Bd. 58 of *Neue Deutsche Chirurgie* (Lexer). 10¼ × 7 in. Pp. 174 + viii, with 39 illustrations. 1937. Stuttgart: Ferdinand Enke. RM. 14; bound, RM. 16.

IN this volume the author describes practically every type of injury and lesion which may occur in modern sport. The first part is devoted to a description of injuries as they affect the various parts of the body; the second section deals with the individual sports and the injuries which are encountered in each special type of physical exercise; and the third part is devoted to an outline of treatment.

Though necessarily compressed, the subject is presented in a systematic fashion and contains a great number of useful references, although mainly confined to the German literature on the subject. The book could certainly not be described as a text-book, but it should prove useful to those surgeons who are frequently called upon to give first aid in injuries caused by physical exercise.

The Technic of Local Anæsthesia. By ARTHUR E. HERTZLER, A.M., M.D., F.A.C.S., Professor of Surgery in the University of Kansas; Surgeon to the Halstead Hospital; etc. Sixth edition. Large royal 8vo. Pp. 284, with 142 illustrations. 1937. London: Henry Kimpton. 21s. net.

PROFESSOR HERTZLER maintains that once a book has survived five editions the author has no need to apologize for his work. To do so would be to reflect on the judgement of those who had acquired it. There can be, therefore, no danger of offering trivial criticism to the sixth edition of a book resting upon such sure foundations.

This work is admirable in its brevity. The type and the paper upon which it is printed are excellent, but the essence of this book's popularity must lie in the charming illustrations.

It differs materially from other books on local anæsthesia because it recommends the injection of a minimum quantity of solution. The author stresses, quite correctly, the importance of accurate anatomical localization of the injection, but, in many cases, is unnecessarily sparing in the quantities he uses, especially when he states that 15 gr. of novocain in 0·5 to 1 per cent solution can be injected with perfect safety and quotes cases in which 40 gr. have been used without ill effect. It is generally agreed that novocain is the solution of choice in most conditions requiring infiltration, but his wholehearted condemnation of cocaine is rather premature. Cocaine in 0·5 per cent solution with 0·5 per cent sodium bicarbonate is a most useful local anæsthetic for the male urethra.

He stresses the importance of waiting a while after the infiltration until complete anæsthesia has been obtained, a point not often fully appreciated by the general surgeon until he himself is seated in the dentist's chair.

Prof. Hertzler, however, has tried the effect of diothane upon his own leg. He advises its use in a 1 per cent solution, and owing to the fact that its action persists for four days, it would seem to have an important application in operations attended by much after-pain.

The author impresses upon the beginner important points of which he is likely to be ignorant, such as the pain caused while operating under local anæsthesia when stretching or crushing viscera or blood-vessels, whereas cutting is painless. The expression 'guts' in this respect to us seems rather crude.

We agree that breast operations, in nearly all cases, are better performed under gas and oxygen than local anæsthesia, but protest against his remark that local anæsthesia for these operations is "a stunt for the young man developing his technique, rather than for the experienced operator who has ceased to thrill at the unusual".

The chapter on spinal anæsthesia has been ably revised by Dr. Irene A. Koeneke. It is interesting to note that fat patients require less spinal anæsthetic solution than thin ones.

We disagree that "most of the rectal diseases belong to the domain of minor surgery and should be quite within the province of the general practitioner". The evil effects of inadequate treatment for rectal diseases are seen so often in every surgeon's practice that most men would hesitate to endorse Prof. Hertzler's queer statement.

All adverse criticism of this classical work involves quibbles on small matters. Its popularity will persist owing to its brevity and its attractive illustrations.

Surgical Nursing. By HUGH CABOT, M.D., F.A.C.S., Senior Consultant, Mayo Clinic, Rochester, Minn.; and MARY DODD GILES, R.N., A.M., Associate Professor of Nursing Education, Vanderbilt University. Third edition. Large post 8vo. Pp. 441, with 121 illustrations. 1937. London: W. B. Saunders Co. Ltd. 13s. net.

THIS is a well-written and readable book, with good and clear illustrations. It is an elementary text-book of medicine and surgery as well as of nursing. One of its main objects seems to be to encourage a nurse to develop the faculty of observation and reading of the patient's mind, as well as taking careful note of the symptoms of the case.

The advice given for the care of the teeth of a patient before operation is good, but perhaps the advice of letting patients brush the teeth four times a day might be difficult to carry out in a busy ward (p. 32).

There are a few very good colour illustrations, but these are all confined to appendicitis and peritonitis. The small bulk of the volume makes it very convenient.

Text-book of Histology for Medical Students. By EVELYN E. HEWER, D.Sc. (Lond.), Reader in Histology in the University of London, and Assistant Lecturer in Physiology at the London (Royal Free Hospital) School of Medicine for Women. Crown 4to. Pp. 365 + x, with 340 illustrations. 1937. London: William Heinemann (Medical Books) Ltd. 15s. net.

THIS is a good and clear description of the microscopical appearances of the normal human tissues. Emphasis is laid throughout on the 'physiological' appearances and their relation to function. The illustrations, which must necessarily form the basis of a work of this kind, are all very clear and intelligible. In most cases the low-power view is shown by a microphotograph and the high-power by a diagrammatic drawing. There is an appendix giving instructions about the most useful methods of histological investigation.

Tissue Reactions in Bone and Dentine. A Morpho-biological Study of the Formation and the Dissolving of Bone and Dentine. By ÅKE WILTON, M.D., Associate Professor and Lecturer in Pathology at the Caroline Institute, Stockholm. 9 × 6 in. Pp. 194, with 64 illustrations. 1937. London: Henry Kimpton. 15s. net.

THIS is a highly abstruse discussion on tissue changes in bone and dentine, especially as they are influenced by various vitamins. The concluding paragraph serves well to show the nature and scope of the book: "The observations of tissue reactions in bone and dentine are discussed in the light of the results of investigations obtained by experimental biology and by cultivations of tissue *in vitro*. The discussion of physiological differentiation and dedifferentiation and of disturbances in the physiological development by the N- and W- factor, results in a hypothesis that the temporary tissue activity is directed by a 'cell mechanism' influenced by 'residual energy' and by the medium."

There are over 200 authorities quoted at the end of the book.

The Role of Chemiotaxis in Bone Growth. By A. P. BERTWISTLE, M.B., Ch.B., F.R.C.S.Edin. Royal 8vo. Pp. 59 + xii, with 32 illustrations. 1937. London: Henry Kimpton. 8s. 6d.

THIS curious little book is an attempt to establish the idea that "whenever young fibrous tissue, particularly young blood-vessels, come into contact with bone or a calcified deposit, new bone formation occurs." We confess that its perusal has led rather to bewilderment than to elucidation.

Die Behandlung der bösartigen Geschwülste der Mundhöhle. By Priv. Doz. Dr OTTO SCHÜRCH, Zurich. Heft 15 of *Vorträge aus der praktischen Chirurgie* (Lexer). Large royal 8vo. Pp. 44. 1936. Stuttgart: Ferdinand Enke. Paper covers, RM. 2.60.

THIS is a short monograph of forty-four pages containing a review of various methods of treating malignant tumours of the oral cavity. Mention is made of treatment by irradiation of different sorts as well as by surgery, and the author states his conviction that progress must come by co-operation between surgeon and radiologist. Comparison of the value of different methods of treatment is not given.

Illustrations of Regional Anatomy. By E. B. JAMIESON, M.D., Senior Demonstrator and Lecturer, Anatomy Department, University of Edinburgh. Second edition. F'cp. 4to. Section I, Central Nervous System, 48 Plates, 7s. Section II, Head and Neck, 63 Plates, 12s. 6d. Section III, Abdomen, 37 Plates, 5s. 6d. Section IV, Pelvis, 33 Plates, 3s. 6d. Section V, Thorax, 30 Plates, 4s. 1936. Edinburgh: E. & S. Livingstone.

THIS consists of a number of separate anatomical diagrams and drawings, arranged in seven parts, and so bound in limp covers that they can be taken out and used separately.

The accuracy of depiction, judiciously combined with diagrammatic representation when necessary, makes it exceedingly valuable for purposes of instruction and reference.

The History of the Surgeons' Company, 1745-1800. By CECIL WALL, M.A., D.M., F.R.C.P., Thomas Vicary Lecturer at the Royal College of Surgeons of England, 1935. With a Foreword by Sir D'ARCY POWER, K.B.E., Hon. Librarian and Hunterian Trustee. Royal College of Surgeons of England. Demy 8vo. Pp. 256, with Frontispiece and 9 other illustrations. 1937. London: Hutchinson's Scientific and Technical Publications. 10s. 6d. net.

THE period under review covers the life and activities of the Company of Surgeons. It is the interval between the separation of the Surgeons from the Company of Barber Surgeons in 1745 and their incorporation as the Royal College of Surgeons in 1800 by George the Third.

Good records of this period still exist, and Dr. Cecil Wall has gathered them together in a convenient form, for which students of the History of Surgery will be grateful.

As might be expected, one of the most important parts of the book deals with the steps that led up to the separation, and then with the details of the separation itself. Then comes an account of the activities of the new Company, of their place of meeting, their possessions, lectures, and finances. Then very soon comes the cry for expansion, and the steps that led to the purchase of a house in Lincoln's Inn Fields for £5500, and the record of the first meeting of the Court in their new home on June 5, 1797.

In the same year it was suggested that the title of Company of Surgeons should be changed to the College of Surgeons, with a President instead of Master at its head. Mr. Earle was also instructed to apply for the King's consent to use the title of 'Royal', and permission was granted.

A bill was promoted in Parliament for the change of constitution and title and was rejected. The bill seems to have been killed by an eloquent speech from Lord Thurlow, who attacked it, among other reasons, on the grounds that aristocracy was a better form of government than democracy.

Perhaps it was a good thing that the first bill was thrown out, for shortly a second and a better bill was brought forward and was passed in 1800. The first meeting of the Royal College of Surgeons was held on April 10, 1800.

It has always seemed a pity that the Surgeons should have remained partners with the Barbers for so long, and it is not clear why they did. Their rapid development after the separation is sufficient evidence of the wisdom of the move.

It is pleasing to note that the unhappy differences with them are now all past, and the healing of the wounds by 'the best intention' is marked by the endowment of a lecture on the History of Surgery by the Worshipful Company of Barbers, from which lecture this book found its origin.

To-day the Royal College of Surgeons is making history again. How much of the credit is due to our forefathers of the eighteenth century who built so wisely?

Life and Death. The Autobiography of a Surgeon. By ANDREA MAJOCCHI, Professor of Surgery, Milan. Translated by H. J. STENNING. Demy 8vo. Pp. 343. 1937. London: George Allen & Unwin Ltd. 10s. 6d.

EVERY English-speaking surgeon should read *Life and Death*. It is the autobiography of Professor Andrea Majocchi, the present Professor of Surgery at Milan, and it shows the fundamental differences between the Latin and Nordic races. Prof. Majocchi tells the story of his life simply and truthfully, and in doing so shows how differently he reacts to the stress and strain of every surgeon's life. He began life with small means and has raised himself by merit to the high position he now holds in the surgical world. Educated at Pavia, there was a chance that he might have remained a dispensary doctor in a small Alpine village; but with characteristic energy he broke away and became an assistant in the public midwifery service at Milan. Here he tells of experiences of which we have no conception—horrible slums, ruffians ready to use their knives on the smallest provocation, and the district so badly policed that the doctor himself had to go armed to his cases. Deserting midwifery, he was appointed surgeon to the General Hospital at Milan. He shows that the practice of surgery in Italy was no easy thing in the days immediately preceding the war. Patients were not trained to come to the hospital in the early stages of disease; there was a definite feeling of caste, duelling was still prevalent, everyone was excitable and emotional. The suggestion of an operation, therefore, had to be approached very tactfully, and a fatal result might result in physical injury to the operator.

Prof. Majocchi gives an interesting account of a pilgrimage to Lourdes, where he went as medical director of the Italian branch. He describes the long journey, the hopefulness of the pilgrims, the intense religious excitement, and, although there were no cures or miracles, the return home with resignation and the feeling of joy that the journey had been undertaken.

During the war Prof. Majocchi was a major in a Red Cross Hospital on the Piave front. Visiting his brother in a neighbouring camp his attention was drawn to the mess sergeant, who was the most modest, taciturn, and serene person imaginable. He was training to become an officer and was officiating as battalion assistant. In private life this curiously attractive man had made a reputation as the municipal officer of a prosperous village on the Tagliamento, a small settlement then in the hands of the enemy, farther behind the Piave. The war, it was said, would soon be over, and the sergeant intended to return to the congenial activities in the province he loved so well. But the fates determined otherwise. His name was Arnaldo Mussolini.

Prof. Majocchi made a trip to the United States and visited the chief medical centres. They did not appeal to him; he became homesick, and was delighted to get back to Italy and be once more amongst his own people in Milan. The whole book is of interest, and it has been well translated by H. J. Stenning, who may be forgiven the few technical slips as he is not a doctor. The moral is that a cultivated gentleman with a tendency to introspection will not have an easy life if he practises as a surgeon in Italy.

BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest for our readers.]

Kleine Chirurgie. By Professor Dr. HANS KURTZAHN, Königsberg. Fourth edition. 8¾ × 6 in. Pp. 468 + viii, with 177 illustrations and a coloured plate. 1937. Berlin and Vienna: Urban & Schwarzenberg. RM. 12; bound, RM. 13.50.

Appendicitis. A Clinical Study. By W. H. BOWEN, Hon. M.A. (Camb.), M.S. (Lond.), F.R.C.S., Hon. Surgeon to Addenbrooke's Hospital, Cambridge; Examiner in Surgery, University of Cambridge, etc. With an Introduction by Sir ARTHUR HURST. Crown 8vo. Pp. 202 + xii. 1937. London: Cambridge University Press. 7s. 6d. net.

Synopsis of Genito-urinary Diseases. By AUSTIN I. DOBSON, M.D., F.A.C.S., Professor of Genito-urinary Surgery, Medical College of Virginia, etc. Second edition. 8¾ × 5⅛ in. Pp. 294, with 112 illustrations. 1937. London: Henry Kimpton. 12s. 6d. net.

The Principles and Practice of Rectal Surgery. By WILLIAM B. GABRIEL, M.S. (Lond.), F.R.C.S. (Eng.), Surgeon to St. Mark's Hospital; Surgeon to the Royal Northern Hospital. Second edition. 9¾ × 6 in. Pp. 363 + x, with 9 coloured plates and 162 illustrations. 1937. London: H. K. Lewis & Co. Ltd. 28s. net.

Die angeborenen Fehlbildungen der menschlichen Hand. By Professor WALTHER MÜLLER, Königsberg. 10 × 6¾ in. Pp. 170, with 116 illustrations. 1937. Leipzig: Georg Thieme. RM. 14; bound, RM. 15.50.

Siebzehn Jahre Strahlentherapie der Krebse. Zürcher Erfahrungen, 1919-1935. By HANS R. SCHINZ and ADOLF ZUPPINGER. 10 × 6¾ in. Pp. 340 + x, with 95 illustrations and 213 tables. 1937. Leipzig: Georg Thieme. RM. 32; bound, RM. 37.

Morphologische Pathologie. By Professor Dr. WERNER HUECK, Leipzig. 10¾ × 7 in. Pp. 818 + xx, with 811 illustrations, some coloured. 1937. Leipzig: Georg Thieme. RM. 52; bound, RM. 54.

Précis de Diagnostic chirurgical. Published under the direction of Professor CH. LENORMANT, Paris. In four volumes. 7¾ × 5¼ in. Vol. I. General, by CH. LENORMANT and J. SÉNÈQUE. Head and Neck, by P. WILMOTH. Pp. 764, with 196 illustrations. Fr. 80; bound, Fr. 105. Vol. II. Thorax, Breast, Abdominal Wall, External Genital Organs, by J. PATEL. Pp. 490, with 138 illustrations. Fr. 50; bound, Fr. 70. Vol. III. Abdomen and Pelvis, by G. MÉNÉGAUX. Pp. 964, with 212 illustrations. Fr. 100; bound, Fr. 125. Vol. IV. Extremities, by J. SÉNÈQUE. Pp. 630, with 168 illustrations. Fr. 70; bound, Fr. 90. 1937. Paris: Masson et Cie.

Crippled Children: Their Treatment and Orthopedic Nursing. By EARL D. MCBRIDE, B.D., M.D., F.A.C.S., Assistant Professor of Orthopedic Surgery, University of Oklahoma School of Medicine, etc., in collaboration with WINIFRED R. SINK, A.B., R.N., Educational Director, Grace Hospital School of Nursing, Detroit, Mich., etc. Second edition. 9¼ × 6 in. Pp. 379, with 195 illustrations. 1937. London: Henry Kimpton. 18s. net.

Diagnostisch-therapeutische Technik für den Chirurgen. By Dr. med. RUDOLF GEISSENDÖRFER, Breslau. With an Introduction by Professor Dr. K. H. BAUER, Breslau. Demy 8vo. Pp. 509 + xxiv, with 148 illustrations and 2 coloured plates. 1937. Leipzig: A. Barth. RM. 16; bound, RM. 18.

The Management of Fractures, Dislocations, and Sprains. By JOHN ALBERT KEY, B.S., M.D., St. Louis, Mo., and H. EARLE CONWELL, M.D., F.A.C.S., Birmingham, Ala. Second edition. 10¼ × 6¾ in. Pp. 1246, with 1222 illustrations. 1937. London: Henry Kimpton. 52s. 6d. net.

The Therapeutic Problem in Bowel Obstructions. A Physiological and Clinical Consideration. By OWEN H. WANGENSTEEN, B.A., M.D., Ph.D., Professor of Surgery of the University of Minnesota and Surgeon-in-Chief of the University of Minnesota Hospital. 10 × 6½ in. Pp. 360 + xxi, with 90 illustrations. 1937. London: Baillière, Tindall & Cox. 27s. net.

Genital Abnormalities, Hermaphroditism, and Related Adrenal Diseases. By HUGH HAMPTON YOUNG, M.A., M.D., Sc.D., F.R.C.S.I., D.S.M., Professor of Urology, The Johns Hopkins University, etc. 10¼ × 6¾ in. Pp. 650 + xlii, with 379 illustrations. 1937. London: Baillière, Tindall & Cox. 45s. net.

Transactions of the Institute of British Surgical Technicians. Vol. II, No. 1. Demy 4to. Pp. 96, with illustrations. 1937. London. 30s. net.

Il Cancro della Mammella. Studio Anatomo-patologico e Clinico. By GIAMPAOLO COGGI. Vol. XIII of *Collanà di Attualità chirurgiche* (Diretta da Prof. Mario Donati). 10 × 7 in. Pp. 192, with 42 illustrations. 1937. Bologna: Licinio Capelli. L. 35.

Primary Carcinoma of the Lung. By EDWIN J. SIMONS, M.D. With a Foreword by J. ARTHUR MYERS, M.D., Professor of Medicine and Preventive Medicine and Public Health, University of Minnesota, Minneapolis. 9 × 6 in. Pp. 263, with 30 illustrations and 2 coloured plates. 1937. Chicago: The Year Book Publishers Inc. (London: H. K. Lewis & Co. Ltd.) 21s. net.

The Collapse Therapy of Pulmonary Tuberculosis. By JOHN ALEXANDER, B.S., M.A., M.D., F.A.C.S., Professor of Surgery, University of Michigan, etc., with contributions by MAX PINNER, JOHN BLAIR BARNWELL, and KIRBY SMITH HOWLETT, jun. 10½ × 7½ in. Pp. 705 + xvi, with 367 illustrations. 1937. London: Baillière, Tindall & Cox. 67s. 6d.

Practical Proctology. By LOUIS A. BUIE, A.B., M.D., F.A.C.S., Head of Section on Proctology, The Mayo Clinic; Professor of Proctology, The Mayo Foundation for Medical Education and Research, Graduate School, University of Minnesota. 9¼ × 6 in. Pp. 512, with 151 illustrations. 1937. London and Philadelphia: W. B. Saunders Co. Ltd. 30s. net.

Schmerzen und Leistungs-störungen bei Erkrankungen der Wirbelsäule. By Dr. med. EDUARD GÜNTZ. 9¾ × 6½ in. Pp. 171 + viii, with 88 illustrations. 1937. Stuttgart: Ferdinand Enke. Paper covers, RM. 15.20.

Der Schock und verwandte Zustände des autonomen Systems. By Prof. Dr. EDUARD REHN, Freiburg. Heft 16 of *Vorträge aus der praktischen Chirurgie* (Lexer). Large royal 8vo. Pp. 42. 1937. Stuttgart: Ferdinand Enke. Paper covers, RM. 2.60.

Surgical Pathology of the Diseases of the Neck. By ARTHUR E. HERTZLER, M.D., Surgeon to the Agnes Hertzler Memorial Hospital, Halstead, Kansas; Professor of Surgery, University of Kansas. 9¼ × 6½ in. Pp. 237 + xviii, with 206 illustrations. 1937. London: J. B. Lippincott Co. 21s. net.

Speech Training for Cases of Cleft Palate. By M. C. OLDFIELD, M.Ch. (Oxon.), F.R.C.S. Cr. 4to. Pp. 20 + iii, with 38 illustrations. 1937. London: H. K. Lewis & Co. Ltd. 4s. 6d. net.